THE GLASS INDUSTRY

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ENGINEERED GLASS

Located in western Pennsylvania in the borough of Swissvale, and in one of the glass producing centers of the United States where the giant plants for mass production of glass products are found, is Kopp Glass, Inc., a plant whose policy is to produce engineered glass for specific applications. Here, glass products are designed and produced for each individual user's requirement, and the result is the manufacture of a variety of types, composition, colors, sizes and shapes of products. This establishes a manufacturing procedure involving numerous lots of relatively small sized orders, plus maximum utilization of individual glassmaker's know how, with minimum dependence on mass production machinery.

History

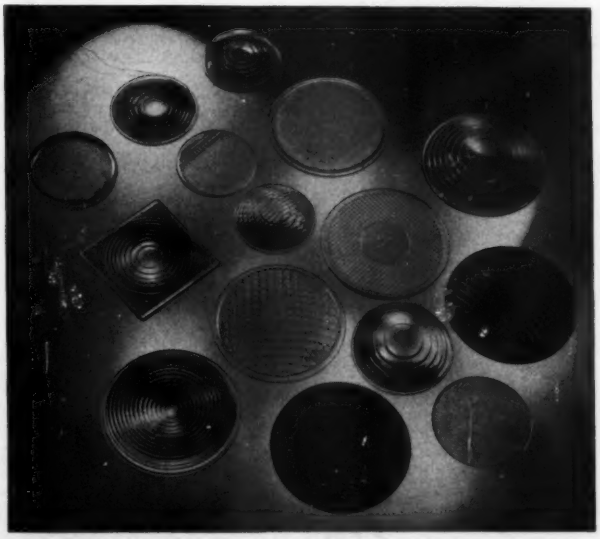
The Kopp Lamp and Glass Company was first organized and formed in 1901 under the leadership of Nicholas Kopp, noted color glass manufacturer and the first man to successfully produce selenium red glass in the United States. The company originally manufactured globes and shades for kerosene and gas lamps, and for the elaborate chandeliers which were then the vogue of the period. These items were made in crystal, opal and a large variety of colors.

In 1902, at the request of the Union Switch & Signal Company, also located in Swissvale, Mr. Kopp began experimenting with signal glass using his knowledge of glass colors to produce improved transmission and purity of color. Red glass received particular attention. As a result of this work, signal glass became an important though minor part of the factory's output and remained so for many years.

The Kopp Lamp and Glass Company was absorbed by the Pittsburgh Lamp, Brass, and Glass Company in 1907, and remained a part of the latter company until it was dissolved in 1926. In May 1926, this plant became an independent firm under its present name of Kopp Glass, Inc.

The development of the fluorescent tube in the immediate period after Mr. Kopp's death in 1937 resulted in a gradual decline in demand for the globes which were used with the incandescent lamp. It seemed therefore wise to abandon the standard lighting glassware which was still the greater portion of production.

Using its many years of experience in the signal glass field as a foundation, the company began to concentrate on the development of an organization which would be carefully selected and thoroughly trained to work on the production of signal, industrial and technical glass products. Today the company has a small but well qualified group of physicists, chemists and engineers who are thoroughly familiar with the production of specialty glass. These men in turn are supported by experienced factory personnel.

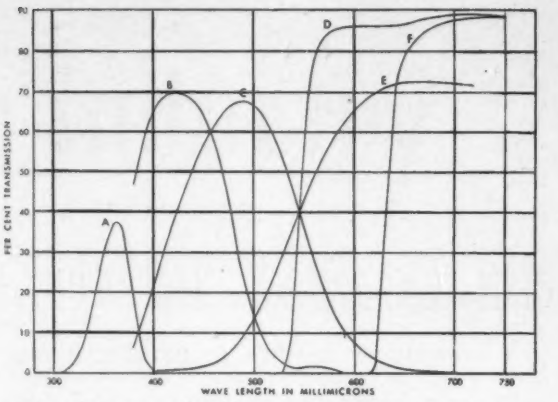


Exemplifying Kopp's lens production is this assortment, including condensing, diffusing and deflecting lenses.

Products

As a general rule, few of the items produced are sold directly to the consumer. Practically all the glass produced is used by other manufacturers in

their equipment and purchased by these manufacturers. In most cases, such manufacturers turn their glass problem over to Kopp Glass who design and develop the item. The job often requires the solution of optical problems by the engineering staff, laboratory work to develop the glass and the manufacturing process, and chemical research to develop the batch. In order to ensure that the final product meets all requirements, the engineers also set up production control and test procedures. The engineering and development work is under the direction of Dr. C. E. Leberknight, Director of Research, who is nationally recognized as an authority in the specialty glass field.



Representative transmission curves for filter glasses.

In order to meet the great variety of glass required, more than 125 types of glass are produced. As many as twenty varieties may be in melt at one time. Special requirements also must be considered, such as low expansion, high impact strength and transmission of particular wave lengths, as required by railroad, traffic, marine, aircraft and airport signal glass users. Directional beam control is an important factor in many specifications. Colors are specified in accordance with the 1931 International Commission of Illumination's Standard Observer and Coordinate System.

Engineering

Upon receipt of an order for a special item, the engineering department studies the requirements, prepares a design for the article, recommends the type of glass to be used or develops a new formula if necessary, designs the templates, specifies the type of annealing or heat treatment which may be required and establishes inspection and test procedures.

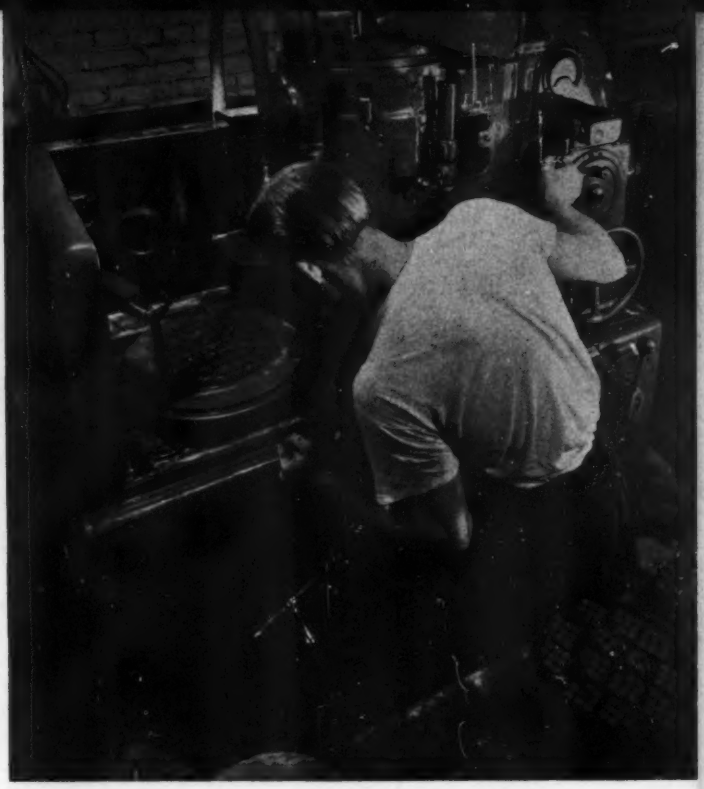
Correct mold design for lenses is of prime importance. In the construction of a lens mold, the profile of the template is designed on a sheet of brass and sent to the mold shop where it is cut out with exacting precision. The design has already been calculated to produce the correct type of beam. When the mold has been completed, samples are made and are processed according to the specifications. They are then turned over to the laboratory to determine if all requirements have been met. On difficult assignments it is not unusual to find it necessary to make design corrections and mold alterations several times before laboratory approval is obtained. There can be no compromise when human safety is at stake. Finally, when all the tests show that the article is satisfactory, the item is put on the regular production schedule. The engineering department's responsibility, however, does not end with the acceptance of the article. They must constantly check on subsequent production runs of the item to guard against mold wear and other possible defects which may develop.

Raw Materials

A great variety of chemicals are required in the manufacture of signal and technical glass. Extreme care must be taken to insure purity and uniformity in these products. Close attention is necessary in the preparing of the batches. In some glasses a variation of only $\frac{1}{64}$th of an ounce in a 1000 lb. batch makes an appreciable difference in the finished product.

Batch materials are weighed on a Kron springless dial platform scale. An ingenious system has been developed

(Left) Integrating sphere and photometer for determining the light output of small test lamps. A larger sphere is available for larger lamps. These lamps are used as the standard light source for lens investigations. (Right) Looking down a 75-foot photometric tunnel used for checking the beam distribution of lenses.



(Above) Each batch is mixed individually in a Lancaster Mixer with extreme care being employed in weighing the various components.

(Right) The high degree of grinding accuracy required for many Kopp products is accomplished with a Blanchard Grinding Machine.

for weighing the batch materials which is part of the scale operation procedure. Individual dials have been made up for all the batches which are regularly mixed. These dials are marked with the required ingredients of the batch, each mark being located so that when they line up with the pointer, the correct amount of the ingredient has been added. Then the next ingredient is added until the next mark is lined up. Thus mistakes in weighing of the batch materials are minimized. Materials which are added in minute quantities are weighed separately on a precision scale in the color room.

After the batches are weighed, they are mixed in a Lancaster No. 4 counter flow batch mixer. From the mixer, the batch is taken from the well below the mixer on a Jeffrey inclined belt conveyor, and is discharged from the conveyor into batch carts. Proper additions of suitable cullet are added after which the batch carts are raised to the charging floor by means of an electric freight elevator.

Correct charging and melting procedure is under the supervision of men thoroughly trained in the eccentricities of the many varieties of glass. Length of melt and treatment of the metal varies greatly and extreme care must be taken to insure good results.

Glassmaking

On the main floor in the furnace building are two muffle pot furnaces and several small day tanks. The

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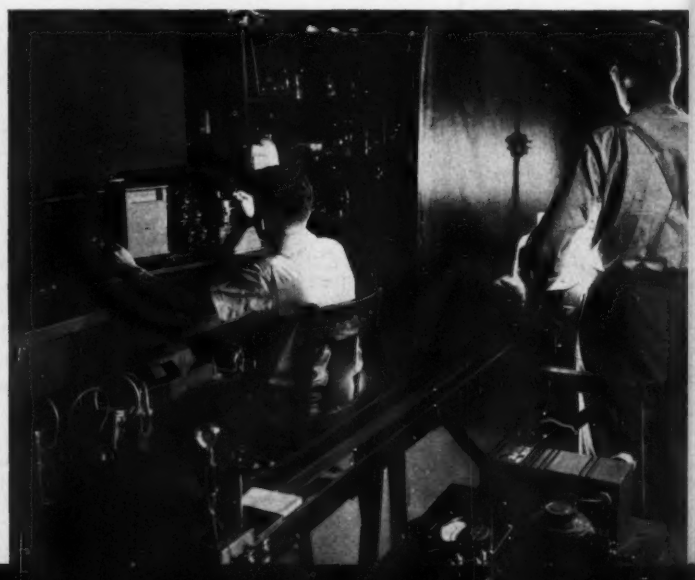
(Left) In the Inspection Department, a photometric bench is used to check color and transmission lenses and other colored articles against National Bureau of Standards Limit Glasses. Every piece of specification glass is tested on this device. (Right) A color-corrected photo cell is used for checking the beam pattern and light distribution of lenses. The intensity of calibrated light source is controlled by an automatic voltage regulator. This equipment is used for experimental designs as well as for production line checking.



G.C.M.I. HOLDS SEMI-ANNUAL MEETING IN CHICAGO

The Glass Container Manufacturers Institute held its semi-annual industry meetings on October 25 and 26 at the Hotel Knickerbocker in Chicago to receive reports of committee activities since the annual meeting last May.

The meeting was called to order by Robert L. Warren, President, and Chairman of the Institute's Board of Trustees. Following Mr. Warren's opening remarks, the Committee on Labor Relations submitted its report. In the absence of Louis C. Roche, Chairman of the Committee, the report was delivered by the Committee Secretary, Ralph A. Lind.

The Committee reported that there have been no labor disputes of any importance or labor disturbances in the plants of the glass container industry since the annual meeting, and commented that the present status and outlook of labor relations within the industry reflected the current situation throughout industry in general.

Since last Spring, the Committee has kept the members of the Institute informed on labor conditions through a series of 26 releases, including reports on meetings with the American Flint Glass Workers Union and the Glass Bottle Blowers Association.

The report of the Committee on Testing Procedures was delivered by Dr. L. G. Gehring, of Preston Laboratories.

J. M. Foster, of Foster-Forbes Glass Co., delivered the report of the Committee on Container Design and Specifications, of which he is Chairman. It revealed progress made in bringing specifications in container drawings up to date and developing new container lines. Typical changes were in the form of revised weights and additional sizes for catsup bottles and the new tall 1-Way Beer Bottle. Drawings and specifications for a new one-pint wine flask are to be available soon.

The Committee further reported that the Los Angeles Fire Department has authorized the use of glass containers for a number of products already marketed elsewhere in glass. Authorities of the City of Cleveland have arranged to receive data from the Committee for reference in the current revisal of the Building Code.

Following Chairman Foster were the reports of his two sub-committees: the Sub-Committee on Beer Bottles, under the Chairmanship of G. A. Mengle, and the Sub-Committee on Milk Bottles, under the Chairmanship of R. M. Lamb, Jr.

Confirming an oral report given at the last annual meeting, Chairman Mengle submitted a written report on problems discussed at the joint meeting of the Sub-Committee with the Brewers Container Committee of the United States Brewers Foundation and the Small Brewers Committee held April 1, 1948 at the Roosevelt Hotel in New York City.

At this meeting, considerations involving the stippling of 1-Way containers were discussed but recommendations were withheld pending the assembling of additional data. The current status of flash finishing was reviewed. The new specifications embodying a shoulder contour for the 11-ounce Export Beer Botttle were agreed to be satisfactory. Need was stressed for uniform standards in amber color to meet brewers' approval. Tentative designs for 7- and 8-ounce capacity Tall 1-Way Beer Bottles have been submitted to the Chairman of the Brewers' Containers Committee.

On behalf of Chairman Lamb, Royden Blunt, President of Buck Glass Company, delivered the report of the Sub-Committee on Milk Bottles. It recalled that there were several states which formerly, by regulation or statute, require the use of a manufacturer's number on milk bottles. As all of these states have accepted the milk bottle code, they have consented to consider the code markings as satisfying the technical requirements for manufacturer's identification in lieu of the number. The Glass Container Manufacturers Institute has provided the manufacturers with a printed form for use in registered mold shape symbols which has proved exceedingly useful.

At a joint meeting in Washington last July with the Milk Industries Foundation, the Sub-Committee discussed the problem of the uniform fill point. As a consequence, three large dairy companies are now conducting laboratory tests on a wide variety of bottles of various finishes and different fill points, with a view to establishing grounds on which a mutually agreeable solution to the problem of the uniform fill point can be achieved.

The Committee on Standards for Finishes, under Chairman C. C. Green, of Armstrong Cork Co., reported the results of its work of reviewing and re-engineering the finishes shown on former G.C.A. drawings. Specifications were thoroughly checked and only those sizes were included that are currently in use. Stated ideal dimensions with plus and minus tolerances are employed instead of maximum and minimum dimensions as in the past. Sealing surfaces are indicated by heavy lines and notes have been explained and clarified to increase the usefulness of the drawings.

The report of the Traffic Committee was presented by its Chairman, I. L. Dunnington, of Anchor Hocking Glass Corp. In the Committee's May 1948 report the several general increases in rail freight rates made effective from July 1946 through January 1948 were summarized. Since then the Committee reported that the Interstate Commerce Commission had authorized another general percentage increase in rates. This latest increase amounts to 10 percent in Eastern Territory, 5 percent in Southern Territory and 5 percent in the Eastern portion of Western Territory, with no change in the remaining part of Western Territory. Interterritorially between Southern and Western Territories and between those two Territories on one hand and Eastern Territory on the other, the increase authorized was 5 percent.

These increases, according to the Committee report, which were first permitted on an interim or emergency basis, became effective May 6, 1948. With some minor modifications, the Commission subsequently authorized these increases, in addition to those previously authorized as interim rate adjustments in the same proceeding, to be made permanent (and they were so re-published) effective August 21, 1948.

At the present rate of production and shipment, the Committee estimates the increase made effective May 6, 1948 will add a further $1,850,000, on an annual basis, to the transportation costs of the industry.

In an attempt to have rate increases held down to a percentage which would not produce rates in excess of the railroad's actual needs, the Institute intervened in two Ex Parte general rate increase proceedings that have been before the Commission since January 1946. Because, however, the Committee believed that the freight rates on sand were already unreasonably high, a specific case was made for the industry on sand rates in the two general rate increase proceedings. The average rate on sand now exceeds its cost at pits or processing points, and brings railroad earnings on this traffic to what the Committee believes to be an inordinately high level. Hence the Institute will join with the National Sand Association in a formal complaint, to be filed with the Commission by the latter, seeking a downward adjustment in the rates on sand for glass-making purposes.

The I.C.C. order for the establishment of uniform classification ratings for nation-wide application and the ultimate publication of a single scale of class rates for application throughout the country (except in Mountain-Pacific Territory) has been progressed by the railroads with the public docketing of their first two proposals. According to the Committee, it would appear that the railroads' idea of classification uniformity is to advance the ratings and raise the carload minima on many commodities, particularly in Eastern Territory. The Committee believes the direction this subject is taking will have to be altered.

According to the Committee's report, it has been announced that all railroads will shortly file a petition with the Commission for authority to make effective another general increase in freight rates of 13 percent. (Editor's note: This petition has subsequently been filed.) It is the Committee's belief that the railroads will encounter more opposition from industry on this petition than in the last two rate proceedings. The basis for this belief is that there are now a large number of important railroads in a healthy financial condition and no longer in need of higher rates. It is also known that a number of railroads realize that the present level of rates has priced them out of a substantial movement of traffic. The general feeling among shippers is that the Commission will examine, with a critical eye, any evidence introduced by the railroads for permission to make another general increase in freight rates.

The report of the Committee on Packaging Design and specifications was submitted by its Chairman, P. A. Parker, of Anchor Hocking Glass Corporation, but it was delivered by John G. Turk of Preston Laboratories, who is in charge of the Institute's Carton Laboratory at Butler, Pa.

With the advice and assistance of technical personnel in the industry, this Committee has continued its long-range Carton Research and Development Program along specific lines. Its 1948 Freight Car Survey, under which shipments of glass packed products are being examined at the time and place of unloading from cars, reveals the elimination of abnormal breakage in certain types of containers as the result of recommendations made concerning their packing in accordance with the findings of a similar Freight Car Survey conducted in 1946-1947.

The Committee is making progress in the study of new and revised specifications for the reshipping cases to be recommended in connection with the supplying of liquor bottles to distilleries. The first draft of the G.C.M.I. Standard Color Catalogue for printing on fibre cases are being prepared, with the expectation that many economies will result if the standards for printing colors as recommended are adopted. Instrumental studies of the cushion tests in the Carton Laboratory at Butler, Pa., indicate that this activity may prove very useful in evaluating the role that partition materials play in inner packing.

The Carton Laboratory is building a library of the packaging specifications used by the U. S. Armed Services, the Federal Government and various private companies. The report requests the industry to submit its problems on packaging specifications to the Committee, inasmuch as inconsistencies in the specifications are frequently worked out in this way.

The Committee has continued its efforts to support the activities of the other Committees of the G.C.M.I. and it at present is cooperating with the Testing Procedures Committee in its study of the hydrodynamic breakage problem and with the Traffic Committee in its recommendations regarding Classification Rule 41.

The report of the Technical Committee on Glass Packed Products was submitted by its Chairman John M. Scharf, of Armstrong Cork Co. According to the report, the Committee met with the National Canners Association on June 9 and 10 and obtained final approval from its Scientific Research Committee for the proposed Bulletin 30-L on Retort Processing Studies. The impetus which this bulletin is expected to give to certain types of food packing will probably give rise to new problems, calling for more intensive research and still greater collaboration. The Food Technology Abstracts being produced by the research projects at the University of Massachusetts are proving very valuable to technicians in the industry, according to the Committee.

Lewis F. Gayner, of the Gayner Glass Works, reported the activities of the Committee on Government Relations, of which he is Chairman. Data on imports and exports of glass containers

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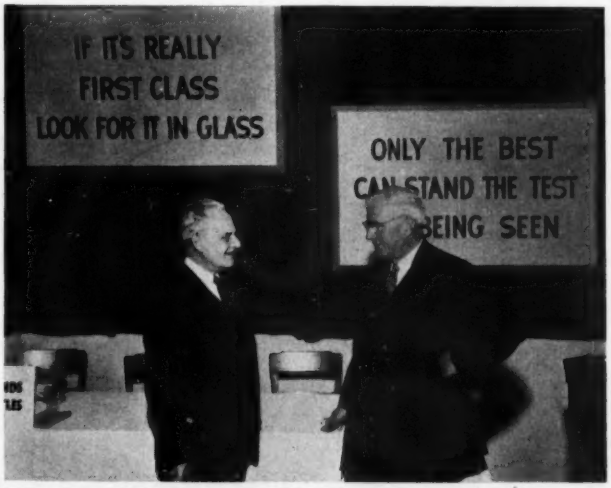


George F. Lang, left, President of Carr-Lowery Glass Co., and I. J. Collins, Board Chairman of Anchor Hocking Glass Corp. and also Chairman of the G.C.M.I. Marketing Committee, discuss 1949 merchandising plans for the One-Way Beer Bottle.

X-RAY ABSORBING AND TRANSMITTING GLASSES

By LAURA L. SUN and KUAN-HAN SUN

The absorption or transmission of electromagnetic waves of or through a homogeneous substance may be expressed by the following general relationship (equation (1)):

$$I = I_o e^{-\mu t} \qquad (1)$$

where

I_o = the initial intensity of the radiation;
I = the intensity after passage through the substance;
t = the thickness of the absorbing or transmitting substance; and
μ = the absorption coefficient which is a function of the wave length of the electromagnetic waves (λ), and the chemical and physical nature of the absorbing or transmitting substance.

The equation is a universal one and is applicable to radiations such as γ-rays, x-rays, ultraviolet rays, through visible to long infrared rays.

In the case of x-rays, the absorption is mainly due to Compton scattering and Einstein photoelectric effect. The absorption coefficient, μ, may be split into two parts as shown in equation (2):

$$\mu = \frac{\mu}{\rho} \cdot \rho \equiv \omega\rho \qquad (2)$$

where

ρ = the density of the absorbing material; and

$\omega \equiv \frac{\mu}{\rho}$ = the mass absorption coefficient.

The mass absorption coefficient, ω, which is composed of mass scattering and mass photoelectric coefficients, is independent of physical state (whether a gas, a liquid or a glass, or a solid), temperature and pressure, and is dependent only on the wave length of the x-rays, the atomic number and atomic mass or weight of the elements in the absorbing material. For any chemical compound or substance, its mass absorption coefficient can be shown to be *additive* of the mass absorption coefficients of the constituent atoms or components.

If the composition, the density, ρ, and the mass absorption coefficients, ω, of the components of a substance are known, it is obvious that the absorption coefficient, μ, of the substance (appearing in equations (1) and (2)) can be calculated. Consequently, the absorption or the transmission is obtained. For example, the mass absorption coefficient of an oxide (M_mO_n), $\omega_{M_mO_n}$, may be calculated as in equation (3):

$$\omega_{M_mO_n} = f_M\omega_M + f_O\omega_O \qquad (3)$$

where ω_M and ω_O are the mass absorption coefficients of the metallic elements, M, and oxygen, O, which are a function of wave-length only; and f_M and f_O are the weight fractions of M and O in M_mO_n. The weight fractions may be calculated from equations (4) and (5):

$$f_M = \frac{mW_M}{W_{M_mO_n}} \qquad (4)$$

and

$$f_O = \frac{nW_O}{W_{M_mO_n}} \qquad (5)$$

in which W_M and W_O are the atomic weights of M and O respectively and $W_{M_mO_n}$, the formular weight of the oxide, M_mO_n.

For a glass composed of many oxides, the mass absorption coefficient, ω_{glass}, can be similarly calculated by the additive relationship as shown in equation (6):

$$\omega_{glass} = \Sigma\,(f_{M_mO_n}\,\omega_{M_mO_n}) \qquad (6)$$

where $f_{M_mO_n}$ and $\omega_{M_mO_n}$ are the weight fractions and mass absorption coefficients of the oxide components in glass and the summation covers all components.

The mass absorption coefficient of all the elements ranging from the short wave-length (0.01 A. or 1.2 mev*) to their characteristic K-critical absorption wave lengths may be calculated from an empirical equation (7) after Victoreen[1]:

$$\omega \equiv \frac{\mu}{\rho} \equiv C\lambda^3 - D\lambda^4 + E \cdot F \qquad (7)$$

where the constants C and D are related with the atomic number (Z) and atomic weight (A) of the element in certain empirical and complicated mathematical forms; λ, the wave-length of the x-ray in A-units; E is the total scattering of all electrons and F equals (Z/A). All these "constants" are given for all the elements from atomic number 1 to 92 by Victoreen and are reproduced in Tables I and II.

From equation (7), the mass absorption coefficient of any element at any wave-length smaller than the char-

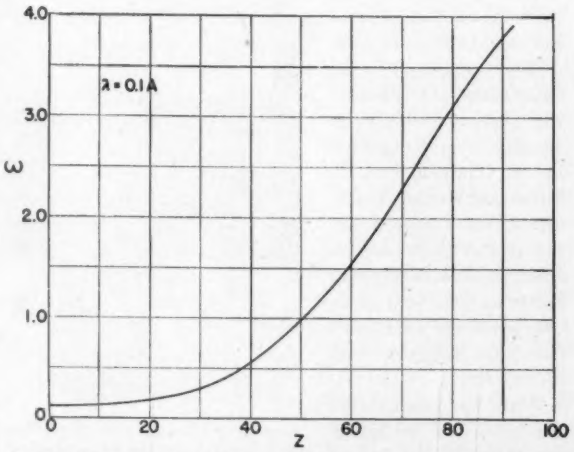


Figure 1. Mass absorption coefficient, ω_M, of elements, vs. atomic number, Z, for the wave length, 0.1 A.

* Million electron volts.

[1] J. A. Victoreen, "Probable X-Ray Mass Absorption Coefficients for Wave-Lengths Shorter Than the K Critical Absorption Wave-Length," Jour. Appl. Phys., *14*, 95 (1943).

Table I. Values of C, D, Z/A, and λ for the elements. Wave-length in angstroms.

Z	C	D	F	Limit λK	Z	C	D	F	Limit λK
1	01289	4.662×10^{-6}	0.9922		47	808.8	624.8	0.4356	0.4844
2	05197	75.16×10^{-6}	0.4997	504.2	48	854.1	692.2	0.4270	0.4631
3	0.1517	493.6×10^{-6}	0.4322		49	904.3	768.6	0.4269	0.4429
4	0.3689	2133×10^{-6}	0.4434		50	952.3	842.0	0.4212	0.4239
5	0.6006	006791	0.4621	64.3	51	1010	941.9	0.4188	0.4060
6	1.211	01830	0.5000	43.5	52	1042	1017	0.4074	0.3892
7	2.034	03963	0.4997	31.1	53	1140	1163	0.4175	0.3734
8	3.161	0.07739	0.5000	23.5	54	1194	1273	0.4112	0.3577
9	4.404	0.1324	0.4736		55	1258	1401	0.4140	0.3440
10	6.487	0.2353	0.4954		56	1330	1548	0.4076	0.3307
11	8.503	0.3661	0.4783		57	1421	1725	0.4103	0.3181
12	11.65	0.5876	0.4934	9.496	58	1524	1928	0.4139	0.3062
13	14.69	0.8583	0.4820	7.935	59	1621	2140	0.4186	0.2951
14	19.19	1.286	0.4989	6.731	60	1700	2339	0.4158	0.2845
15	23.93	1.768	0.4835	5.774	61	1808	2590	0.4178	
16	29.49	2.538	0.4990	5.008	62	1879	2804	0.4121	0.2644
17	34.34	3.314	0.4794	4.383	63	1990	3090	0.4144	0.2548
18	38.80	4.174	0.4506	3.865	64	2061	3325	0.4068	0.2462
19	49.47	5.903	0.4859	3.431	65	2174	3649	0.4082	0.2376
20	60.08	7.907	0.4990	3.064	66	2274	3968	0.4062	0.2301
21	65.21	9.430	0.4656	2.751	67	2407	4364	0.4097	0.2226
22	78.06	12.36	0.4592	2.491	68	2540	4784	0.4116	
23	84.49	14.60	0.4514	2.263	69	2639	5160	0.4073	0.2085
24	98.72	18.54	0.4614	2.065	70	2748	5571	0.4045	0.2016
25	111.2	22.65	0.4551	1.891	71	2886	6074	0.4057	0.1951
26	129.0	28.41	0.4656	1.739	72	3007	6564	0.4031	0.1901
27	143.0	33.96	0.4580	1.604	73	3144	7115	0.4024	0.1836
28	167.6	42.85	0.4770	1.483	74	3285	7701	0.4021	0.1782
29	178.9	49.09	0.4561	1.377	75	3434	8343	0.4025	0.1735
30	200.7	59.01	0.4588	1.280	76	3543	8911	0.3968	0.1675
31	215.5	67.79	0.4446	1.190	77	3719	9687	0.3987	0.1620
32	236.9	79.60	0.4407	1.116	78	3882	10460	0.3995	0.1577
33	262.2	93.36	0.4405	1.042	79	4070	11354	0.4006	0.1532
34	280.6	106.8	0.4305	0.9777	80	4233	12212	0.3987	0.1489
35	313.7	127.0	0.4379	0.9180	81	4367	13028	0.3963	0.1444
36	337.0	144.9	0.4301	0.8637	82	4537	13998	0.3957	0.1404
37	370.5	168.8	0.4330	0.8141	83	4737	15098	0.3971	0.1367
38	404.7	195.3	0.4336	0.7683	84	4980	16403	0.4565	
39	444.0	226.6	0.4385	0.7255	85	5180	17623	0.4009	
40	481.8	259.8	0.4385	0.6873	86	5117	17978	0.3873	
41	522.7	297.4	0.4394	0.6515	87	5458	19798	0.3901	
42	562.4	337.3	0.4375	0.6184	88	5685	21284	0.3911	
43	609.6	385.4	0.4396		89	5889	22748	0.3886	
44	646.1	429.9	0.4326	0.5584	90	6083	24240	0.3877	0.1127
45	702.9	491.9	0.4372	0.5330	91	6181	25404	0.3888	
46	745.9	548.5	0.4311	0.5079	92	6512	27240	0.3863	0.1065
					H_2O	2.808	0.06873	0.5549	23.5
					Air	2.768	0.1017	0.4993	3.86

The values of λK were taken from Compton and Allison.

Table II. Values of $\sigma_e N_0$. Wave-length in angstroms. Calculated from Klein-Nishina formula.

λ	E	λ	E	λ^3	λ^4	λ	E
0.01	0.113	0.10	0.279	0.001000	0.0001000	1.0	0.387
.012	.125	.12	.293	.001728	.0002073	1.2	.390
.015	.140	.15	.309	.003375	.0005062	1.5	.394
.02	.160	.20	.325	.008000	.001600	2.0	.395
.025	.175	.25	.337	.01562	.003906	2.5	.396
.03	.188	.30	.346	.02700	.008100	3.0	.397
.04	.210	.40	.357	.06400	.02560	4.0	.397
.05	.226	.50	.365	.1250	.06250	5.0	.398
.06	.240	.60	.371	.2160	.1296	6.0	.399
.08	.262	.80	.380	.5120	.4096	8.0	.400

acteristic K-critical absorption limits (Table I) may be calculated with high accuracy.

The mass absorption coefficients, ω_M, of various elements for the arbitrary chosen wave-length, 0.1 A, are calculated and listed in the Column 4 of Table III. They are also plotted against the atomic number, Z, as shown in Figure 1. Since 0.1 A is smaller than the K-critical absorption limits of the elements below uranium, the curve is a continuous one. For a similar curve of longer wave-lengths break or breaks in the curve would be observed; and the mass absorption coefficients, ω_M, will not increase continuously with the atomic number, Z. From these ω_M values and the weight fractions of M in M_mO_n, f_M (Column 3 of Table III), the mass absorption coefficients of various oxides, $\omega_{M_mO_n}$, are obtained by means of equation (3). It is to be noted that f_O equals $(1-f_M)$. The $\omega_{M_mO_n}$ values thus calculated are listed in the Column 5 of Table III and are also plotted in Figure 2 against the valence of the positive elements as they would appear in the Periodic Table. Oxides with their valence state other than normal are plotted along

TABLE III

Oxides	At. No. of M in M_mO_n	Wt. Fraction of M in M_mO_n	Mass Abs. Coef. of M	Mass. Abs. Coef. of M_mO_n	Density of M_mO_n Used	Abs. Coef. of M_mO_n $\mu_{M_mO_n}=(\omega\rho)_{M_mO_n}$ (cm^{-1})	Half-Value Thickness of M_mO_n $\tau_{M_mO_n}=\left[\frac{0.693}{\mu_{M_mO_n}}\right]$ (cm.)	Rel. Abs. Thickness Metallic Pb Taken as Unity*
M_mO_n	Z_M	f_M	ω_M	$\omega_{M_mO_n}$	$\rho_{M_mO_n}$			
H_2O	1	0.1119	0.2768	0.1576	1.000	0.158	4.38	233
Li_2O	3	0.4645	0.1208	0.1325	2.01	0.267	2.60	138
Na_2O	11	0.7419	0.1419	0.1421	2.27	0.323	2.14	114
K_2O	19	0.8301	0.1845	0.1774	2.32	0.412	1.68	89.4
Cu_2O	29	0.8882	0.3013	0.2836	6.0	1.70	0.408	21.7
Rb_2O	37	0.9144	0.4744	0.4460	3.72	1.67	0.415	22.1
Ag_2O	47	0.9310	0.8678	0.8177	7.14	5.84	0.119	6.3
Cs_2O	55	0.9432	1.233	1.172	4.36	5.11	0.135	7.2
Au_2O	79	0.9610	3.046	2.933				
Tl_2O	81	0.9623	3.175	3.061	9.52	29.1	0.024	1.3
BeO	4	0.3605	0.1241	0.1359	3.00	0.408	1.70	90.5
MgO	12	0.6032	0.1493	0.1466	3.58	0.525	1.32	70.2
CaO	20	0.7147	0.1985	0.1826	3.32	0.607	1.14	60.6
ZnO	30	0.8034	0.3228	0.2874	5.66	1.63	0.425	22.6
SrO	38	0.8456	0.5062	0.4501	4.7	2.12	0.327	17.4
CdO	48	0.8754	0.9040	0.8091	8.15	6.59	0.105	5.6
BaO	56	0.8957	1.289	1.169	5.72	6.70	0.103	5.5
HgO	80	0.9261	3.123	2.903	11.22	32.6	0.021	1.1
RaO	88	0.9339	3.666	3.433				
CrO	24	0.7647	0.2256	0.2061				
MnO	25	0.7744	0.2359	0.2149	5.40	1.16	0.597	31.8
FeO	26	0.7773	0.2561	0.2308	5.75	1.33	0.521	27.7
CoO	27	0.7865	0.2674	0.2408	6.46	1.56	0.444	23.6
NiO	28	0.7858	0.2964	0.2635	6.8	1.80	0.385	20.5
CuO	29	0.7989	0.3013	0.2694	6.40	1.72	0.403	21.4
SnO	50	0.8812	0.9856	0.8855	6.25	5.52	0.125	6.7
PbO	82	0.9283	3.248	3.025	9.50	28.7	0.024	1.3
B_2O_3	5	0.3107	0.1295	0.1385	1.81	0.251	2.76	147
Al_2O_3	13	0.5291	0.1491	0.1460	3.80	0.555	1.25	66.5
Sc_2O_3	21	0.6527	0.1942	0.1763	3.86	0.680	1.02	54.2
Ga_2O_3	31	0.7439	0.3327	0.2840	6.09	1.73	0.400	21.3
Y_2O_3	39	0.7875	0.5436	0.4584	4.84	2.22	0.312	16.6
In_2O_3	49	0.8270	0.9465	0.8075	7.04	5.69	0.122	6.5
La_2O_3	57	0.8527	1.3630	1.1832	6.51	7.70	0.090	4.8
Ce_2O_3	58	0.8538	1.4467	1.2560	6.86	8.63	0.080	4.3
Pr_2O_3	59	0.8545	1.5238	1.3228	6.94	9.20	0.075	4.0
Nd_2O_3	60	0.8574	1.5821	1.3768	7.24	9.98	0.070	3.7
$(61)_2O_3$	61		1.6656					
Sm_2O_3	62	0.8624	1.7136	1.4974	7.43	11.1	0.063	3.3
Eu_2O_3	63	0.8636	1.7966	1.5711	7.42	11.6	0.060	3.2
Gd_2O_3	64	0.8673	1.8420	1.6165	7.41	12.0	0.058	3.0
Tb_2O_3	65	0.8690	1.9230	1.6898	7.68	13.0	0.053	2.8
Dy_2O_3	66	0.8713	1.9905	1.7527	7.81	13.7	0.051	2.7
Ho_2O_3	67	0.8730	2.0849	1.8382	8.36	15.4	0.045	2.4
Er_2O_3	68	0.8722	2.1764	1.8465	8.64	16.0	0.043	2.3
Tm_2O_3	69	0.8759	2.2366	1.9767	8.77	17.4	0.040	2.1
Yb_2O_3	70	0.8782	2.3038	2.0406	9.17	18.7	0.037	2.0
Lu_2O_3	71	0.8794	2.3918	2.1205	9.42	20.2	0.034	1.8
Tl_2O_3	81	0.8949	3.1748	2.8562	9.65	27.6	0.025	1.3
Ac_2O_3	89	0.9045	3.7226	3.3807				
P_2O_5	15	0.5640	0.1587	0.1517	2.14	0.325	2.13	113
V_2O_5	23	0.6798	0.2089	0.1877	4.87	0.915	0.758	40.3
Cr_2O_3	24	0.6843	0.2256	0.1994	5.21	1.04	0.666	35.4
Mn_2O_3	25	0.6959	0.2359	0.2075	4.65	0.967	0.717	38.1
Fe_2O_3	26	0.6994	0.2561	0.2220	4.83	1.07	0.648	34.5
Co_2O_3	27	0.7106	0.2674	0.2313	5.18	1.15	0.603	32.1
Ni_2O_3	28	0.7098	0.2964	0.2518				
As_2O_3	33	0.7574	0.3758	0.3192	3.70	1.18	0.587	31.2
Sb_2O_3	51	0.8354	1.033	0.8861	5.18	4.59	0.151	8.0
Bi_2O_3	83	0.8970	3.338	3.009	8.53	25.6	0.027	1.4
CO_2	6	0.2729	0.1407	0.1421	1.53	0.217	3.19	170
SiO_2	14	0.4672	0.1583	0.1499	2.203	0.330	2.10	112
TiO_2	22	0.5995	0.2049	0.1780	4.08	0.727	0.954	50.7
GeO_2	32	0.6941	0.3519	0.2879	3.63	1.04	0.666	35.4
ZrO_2	40	0.7404	0.5781	0.4650	5.98	2.78	0.249	13.2
SnO_2	50	0.7877	0.9856	0.8066	7.00	5.64	0.123	6.6
HfO_2	72	0.8500	2.463	2.115	9.68	20.4	0.034	1.8
PbO_2	82	0.8662	3.248	2.832	9.60	27.2	0.026	1.4
SO_2	16	0.5005	0.1684	0.1555	1.93	0.300	2.31	123
MnO_2	25	0.6319	0.2359	0.2016	4.99	1.01	0.685	36.4
SeO_2	34	0.7116	0.3900	0.3187	3.59	1.15	0.602	32.0
SbO_2	51	0.7919	1.033	0.8474				
CeO_2	58	0.8141	1.447	1.204	7.13	8.60	0.081	4.3
PtO_2	78	0.8592	2.948	2.553	10.2	26.0	0.027	1.4
ThO_2	90	0.8788	3.767	3.328	9.69	32.2	0.022	1.1
UO_2	92	0.8815	3.896	3.451	10.8	37.1	0.019	1.0
N_2O_5	7	0.2594	0.1414	0.1423	2.05	0.292	2.37	126
P_2O_5	15	0.4365	0.1587	0.1496	2.74	0.411	1.68	89.4
V_2O_5	23	0.5602	0.2089	0.1797	3.36	0.603	1.15	61.2
As_2O_5	33	0.6519	0.3758	0.2946	4.09	1.21	0.573	30.5
Cb_2O_5	41	0.6990	0.6156	0.4732	4.46	2.11	0.328	17.5
Sb_2O_5	51	0.7527	1.033	0.8125	7.86	6.38	0.108	5.8
Ta_2O_5	73	0.8189	2.545	2.110	8.02	16.9	0.041	2.2
Bi_2O_5	83	0.8394	3.338	2.825	5.10	14.4	0.048	2.6
SO_3	16	0.4005	0.1684	0.1529	1.97	0.301	2.30	122
CrO_3	24	0.5201	0.2256	0.1858	2.81	0.523	1.32	70.3
SeO_3	34	0.6219	0.3900	0.2965	3.6	1.07	0.647	34.4
MoO_3	42	0.6666	0.6508	0.4813	4.69	2.26	0.306	16.3
TeO_3	52	0.7267	1.054	0.8049	5.08	4.10	0.169	9.0
WO_3	74	0.7930	2.627	2.113	7.16	15.1	0.046	2.4
PoO_3	84	0.8139	3.467	2.848				
UO_3	92	0.8322	3.896	3.266	6.04	19.8	0.035	1.9

* At 0.1 A, $\omega_{Pb}=3.247$, $\rho_{Pb}=11.34$, $\mu_{Pb}=36.9$ and $\tau_{Pb}=0.0188$ cm.

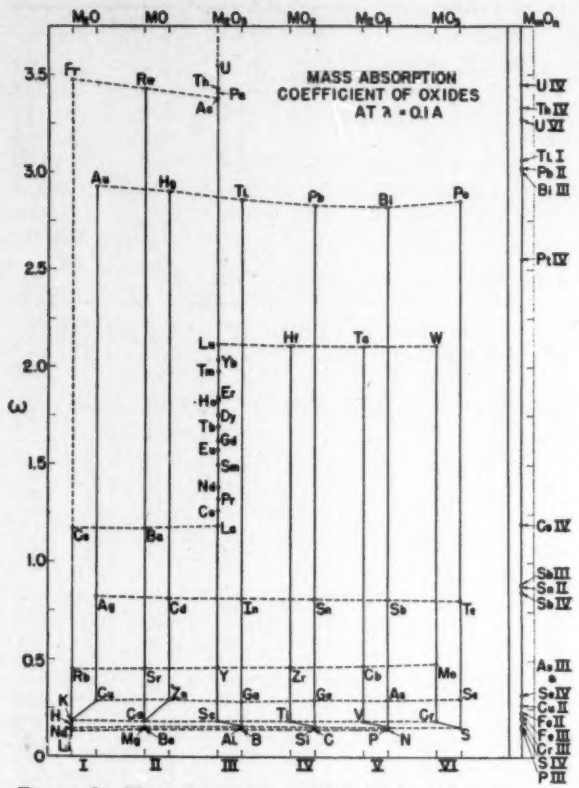


Figure 2. Mass absorption coefficient of oxides, $\omega_{M_mO_n}$, vs. valence state for the wave-length 0.1 A.

the right-hand side of the Figure. It is interesting to note the periodic nature of the mass absorption coefficients. From these values, the mass absorption coefficient of any oxide-glass may be calculated from its composition expressed in weight fractions by means of equation (6). If the density of the glass is known, the absorption coefficient, μ_{glass}, and consequently the absorption, $\left(1-\frac{I}{I_0}\right)$, are obtained (equations (2) and (1)).

Huggins and Sun[2] have shown that the density of a glass, ρ_{glass}, may be calculated from its composition expressed in weight fractions as in equation (8):

$$\rho_{glass} = \frac{1}{\Sigma\,(f_{M_mO_n}\, v_{M_mO_n})} \tag{8}$$

where $f_{M_mO_n}$ represents the weight fraction of the oxide components and $v_{M_mO_n}$ a constant characteristic of the components and the structure of glass. The summation covers all the oxide components in glass. The structure of a silicate glass is determined by a figure, N_{Si}, the atomic ratio of Si to total O in glass, which may be calculated from the composition by means of equation (9):

$$N_{Si} = \frac{f_{SiO_2}}{W_{SiO_2}\,\Sigma\,(nf/W)_{M_mO_n}} \tag{9}$$

where f, W, m and n represent the weight fractions, formular weights, number of positive elements and number of oxygens, of the oxides, M_mO_n, respectively. The summation covers all oxides including SiO_2. Four ranges of N_{Si} have been given to cover the compositions of all silicate glasses. For a given oxide component and a given N_{Si}, $v_{M_mO_n}$ is a constant. These $v_{M_mO_n}$ values for various oxide components are given by Huggins and Sun in the reference mentioned.

By substituting equations (6) and (8) into equation (2), one obtains equation (10) for the calculation of the absorption coefficient of a glass from its compositions expressed in weight fractions:

$$\mu_{glass} = \left(\frac{\Sigma\, f\,\omega}{\Sigma\, f\, v}\right)_{M_mO_n} \tag{10}$$

When the experimental density is known, the obsorption coefficient may be directly calculated from equation (11):

$$\mu_{glass} = \rho_{exptl.}\,\Sigma\,(f\omega)_{M_mO_n} \tag{11}$$

For a single oxide component, f equals unity, equation (11) becomes equation (12):

$$\mu_{M_mO_n} = \rho_{M_mO_n}\,\omega_{M_mO_n} \tag{12}$$

Using the density values of glassy or crystalline oxides from the *Data on Chemicals for Ceramic Use*, National Research Council Bulletin 107, compiled by Kuan-Han Sun under the direction of A. Silverman, G. W. Morey and F. D. Rossini, the absorption coefficients for the arbitrarily chosen wave-length, 0.1 A, of these oxides are calculated and listed in Column 7 of Table III. Since most single oxides do not form a glass by themselves under ordinary laboratory conditions, these absorption coefficients only afford an indirect comparison of the contribution to the absorption coefficient of glass by these various oxide components. It is interesting to note the high values of absorption coefficient for oxides such as Tl_2O, HgO, PbO, Tl_2O_3, Bi_2O_3, ThO_2, UO_2, etc., as well as low values for oxides such as H_2O*, Li_2O, Na_2O, BeO, B_2O_3, CO_2*, SiO_2, SO_3*, etc. The former group of oxides may be incorporated in the x-ray absorbing glasses and the latter in the x-ray transmitting ones.

Another way of comparing the relative absorption of various components is to evaluate the so-called half value thickness, τ, or the thickness of the material required to reduce the initial beam or radiation to one half of its original intensity. The τ values can be evaluated from equation (13) which is obviously derived from equation (1) by taking logarithm on the basis of 10 and setting I/I_0 equal to $\frac{1}{2}$; or we have:

$$\tau \equiv t_{\frac{1}{2}} = \frac{0.693}{\mu} \tag{13}$$

The τ values for all the oxides are thus calculated and given in the Column 8 of Table III, in the unit of cm. When these values are normalized with respect to lead half thickness taken as unity, the lead equivalent thickness is obtained. The latter is equivalent to the thickness of material necessary in order to yield the same absorption as a unit thickness of lead. It gives a comparison of effectiveness of absorption of various substances. The lead equivalent thickness of various oxides are given in Column 9 of Table III. Again it should be cautioned

[2] M. L. Huggins and Kuan-Han Sun, "Calculation of Density and Optical Constants of a Glass From Its Composition in Weight Percentages," Jour. Amer. Ceram. Soc., *26*, 4 (1943).

* These components can be introduced into a glass; see, for example, Kuan-Han Sun, "Glass-Forming Substances," Glass Ind., 27, 552, 580 (1946).

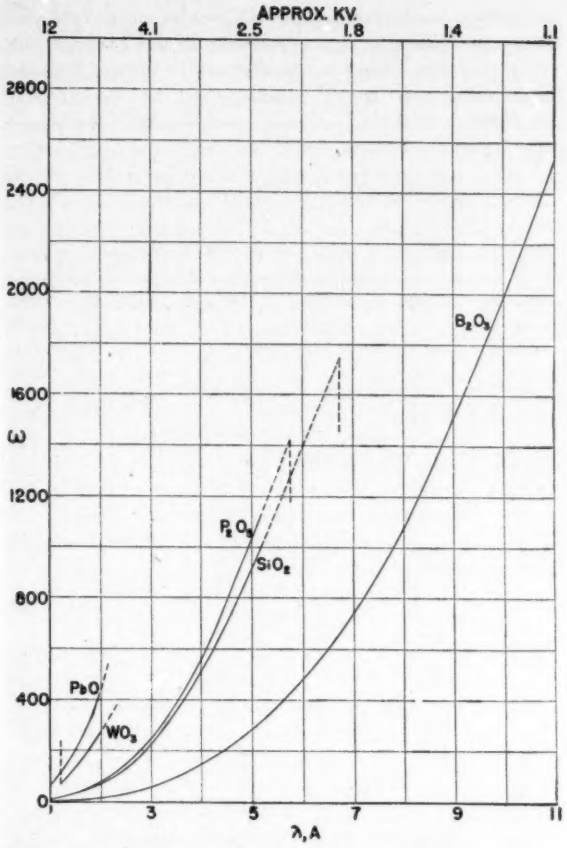


Figure 3. Mass absorption coefficient of oxides, $\omega_{M_mO_n}$, vs. wave-lengths.

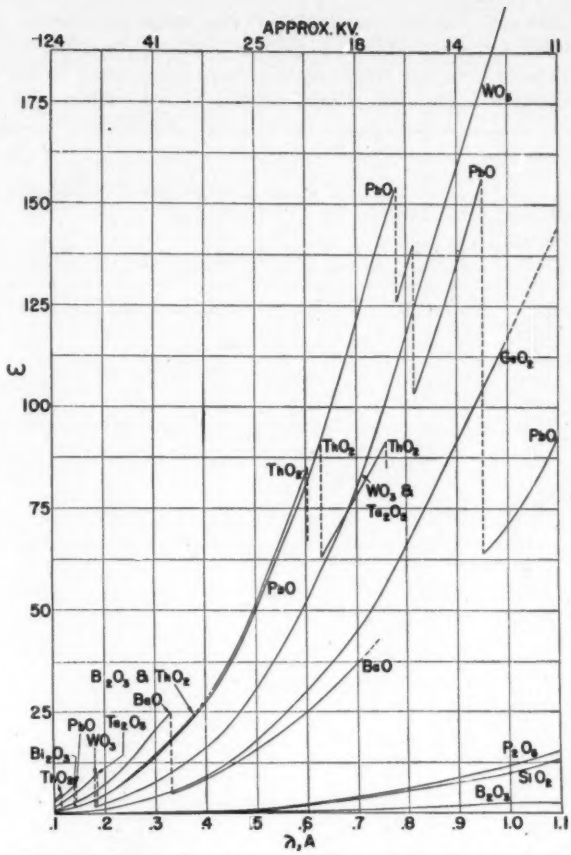


Figure 4. Mass absorption coefficient of oxides, $\omega_{M_mO_n}$, vs. wave-lengths.

that Table III only serves as an illustration. The values and their relative magnitudes vary with the wave-length concerned and with the composition of glass. We shall discuss how the absorption coefficient of an oxide varies with the wave-length and composition in the following sections.

Figures 3, 4, 5 and 6 give the mass absorption coefficient for the heavier oxides, BaO, Ta_2O_5, WO_3, PbO, Bi_2O_3, and ThO_2 which are likely to be used as components in x-ray absorbing glasses, at the wave-length range, 0.01 to 11 A (or about 1200 to 1 kilovolt). Those for the most important glass formers, B_2O_3, SiO_2, P_2O_5 and GeO_2, are also given, since ordinary glasses cannot be formed without the presence of one or more glass formers. These mass absorption coefficients are calculated from equation (3) by using the mass absorption coefficients of elements from various authoritative sources[3], or calculated from (7) after Victoreen. These values are also listed in Table IV together with the mass absorption coefficients of oxygen. It can be seen that the variation through the range of wave-lengths covered is considerable. For a complete coverage, curves of this nature should be

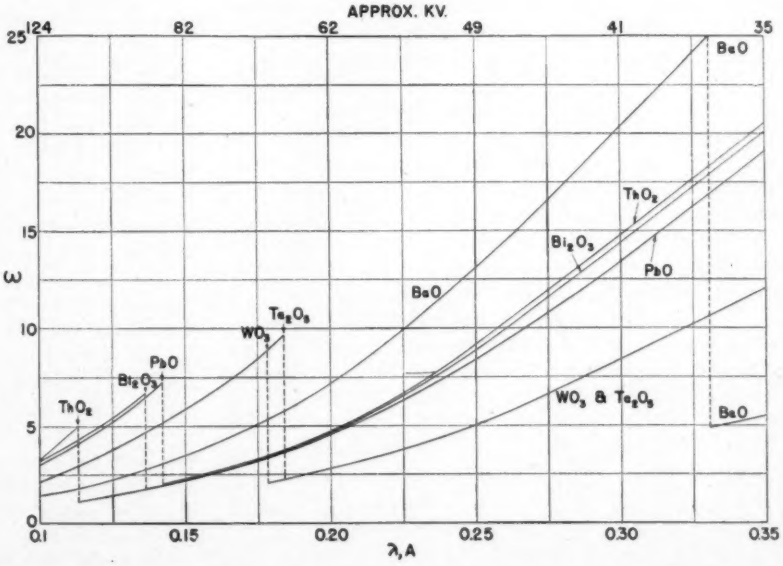


Figure 5. Mass absorption coefficient of oxides, $\omega_{M_mO_n}$, vs. wave-lengths.

[3] A. H. Compton and S. K. Allison, X-Rays in Theory and Experiment, D. Van Nostrand Co., Inc., New York. 1935. M. T. Jones, "The Absorption of Ultra-Short X-Rays by Elements of High Atomic Number," Phys. Rev., *50*, 110 (1936).

obtained and compared for all the oxide components.

In synthesizing glasses for x-ray absorption (the reverse is true for transmission), it is the general belief that the higher the atomic number of the positive (or non-oxygen) element in the oxide component used, the larger the mass absorption coefficient, and consequently the absorption. This is not necessarily always true for three reasons:

TABLE IV

MASS ABSORPTION COEFFICIENTS OF SOME OXIDES AND OXYGEN

Wave Length λ (Å)	B_2O_3	SiO_2	P_2O_5	GeO_2	BaO	Ta_2O_5	WO_3	PbO	Bi_2O_3	ThO_2	O
0.01	0.055	0.056	0.055	0.052	0.048	0.0495	0.050	0.0495	0.051	0.0504	0.056
0.02						0.0865		0.0958			0.080
0.03						0.144		0.178			0.094
0.04						0.238		0.321			0.105
0.05						0.381		0.536	0.540	0.608	0.113
0.06						0.581		0.837			0.120
0.07_2						0.86		1.36			0.125
0.08						1.19		1.73			0.131
0.09						1.51		2.32			0.136
0.09_8	0.141	0.150	0.151	0.328					3.22		0.142
0.10	0.130	0.158	0.159	0.352	1.38	2.11	2.11	3.02		3.33	0.142
0.12					1.95	3.36	3.67	4.70			0.151
0.13	0.154			0.568	2.60				6.02	1.82	0.156
0.14_2							5.39	7.21	1.97		0.160
								1.96			
0.15						5.87					0.166
0.15_8							6.85		2.44		0.169
0.17_5	0.165			1.081	5.13	8.22		3.24	3.25	3.38	0.170
0.17_8							8.99				0.170
							2.18				
0.18_4						9.70			4.59		0.171
						2.32					
0.20	0.180			1.517	7.19	2.82	2.81	4.56		4.67	0.187
0.26	0.209			2.945	14.4	5.52	5.48	9.29	9.99	10.6	0.225
0.30											0.258
0.33_1					25.1			16.8	17.5		0.30
					4.87						
0.38									25.0		0.36
0.40											0.379
0.41_7	0.351			10.47	9.47	17.6	17.9	29.7			0.42
0.49_7	0.461			17.67	16.0	29.5	30.3	49.0		51.6	0.57
0.50											0.573
0.56								69.5			0.72
0.60											0.858
0.63_1	0.79			33.6	28.0	59.1	59.7	90.9		90.8	1.01
										62.5	
0.71	0.95	3.61	4.18	46.8	37.8	82.1	82.8	126		80.1	1.22
0.78								154			1.69
								126			
0.81								139			1.85
								103			
0.85								115			2.20
0.88	1.70	6.68	7.70	87.1				125			2.20
0.90								134			2.48
0.94_9								156			2.87
								63.3			
1.00	2.41	9.62	11.0	116.2			207	69.8		83.9	3.15
1.23_5	4.35	18.5	20.7				76.5	127			5.70
1.38_9	6.16	24.9	28.1								8.10
1.53_9	8.45	34.0	38.1				142	213			11.16
1.93_4	16.6	63.6	70.8				242	398			22.0
2.50	34.2	129.3	145.5								45.5
3.57	111.2	412	407								150
4.36	192	651	726								258
5.17	308	991	1109								413
6.97	730										976
8.32	1194										1589
9.87	1912										2540

1) Since oxygen has a relatively low mass absorption coefficient, its role in oxides serves as a "diluting" agent, thus to decrease the mass absorption coefficient. An oxide of an element of lower atomic number may have equal or slightly higher mass absorption coefficient than an oxide of another element of higher atomic number, if the oxygen content of the former is less than that of the latter. For example, the atomic number of tungsten is 74, and that of lutecium is 71, yet the mass absorption coefficient at the wave-length 0.1 A of WO_3 is 2.11 while that of Lu_2O_3 is 2.12. Figure 2 illustrates the general trend of how the mass absorption coefficient of a given wave-length varies with the atomic number of the elements in an oxide.

2) As shown in equation (2) the absorption coefficient is the product of mass absorption coefficient and density. Although it is generally true that the contribution of glass density by an oxide increases with the atomic number of the element in the oxide, many exceptions may be found[4]. For example, the mass absorption coefficients of WO_3 (atomic number of W being 74) and Ta_2O_5 (the atomic number of Ta being 73) are about the same, yet the density contribution to glass of the former is smaller than that of the latter [4](see also Table III). WO_3 with higher atomic number of W has smaller absorption coefficient than Ta_2O_5 with lower atomic number of Ta.

3) As mentioned above, each element has its own characteristic absorption limits or edges for K, L, M, etc., electrons. The K-absorption limits are most important for the range of x-rays generally interested, though for heavy elements, L-absorption limits also enter into the picture. Although various formulas have been suggested for correlating the wave-lengths of the K-absorption limits with the atomic number, we have found equation (14) to fit experimental data best:

$$\lambda_K(\text{in A}) = 2185\, Z^{-2.19} \qquad (14)$$

where λ_K is the wave-length of the K-absorption limits of an element and Z its atomic number. In general, the mass absorption coefficients of all elements increase as the wave-length of the x-rays increases. As the wave-length reaches the individual K-absorption limits, the mass absorption coefficient drops suddenly. It begins to increase again as the wave-length passes the K-limits, until the L-absorption limits are reached and the process repeats. Since the heavier elements have the K-absorption limits at shorter wave-lengths than that of the lighter ones, the drop of the mass absorption coefficient at the K-absorption limits and beyond may render its value smaller than those of lighter elements, because the absorption coefficient of the latter, having not reached their K-absorption limits, is still increasing in this wave-length region. For example, barium has an atomic number 56, much lower than that of lead which has an atomic number 82, and its oxide contains higher weight of oxygen than that of lead oxide (correspondingly less weight of barium than that of lead in their oxides), yet in the wave-length region, 0.14 — 0.33 A (about 88 — 37 KV), the mass absorption coefficient of BaO is larger than that of PbO. Such examples are numerous and the situation is rather complicated. The choice of oxide

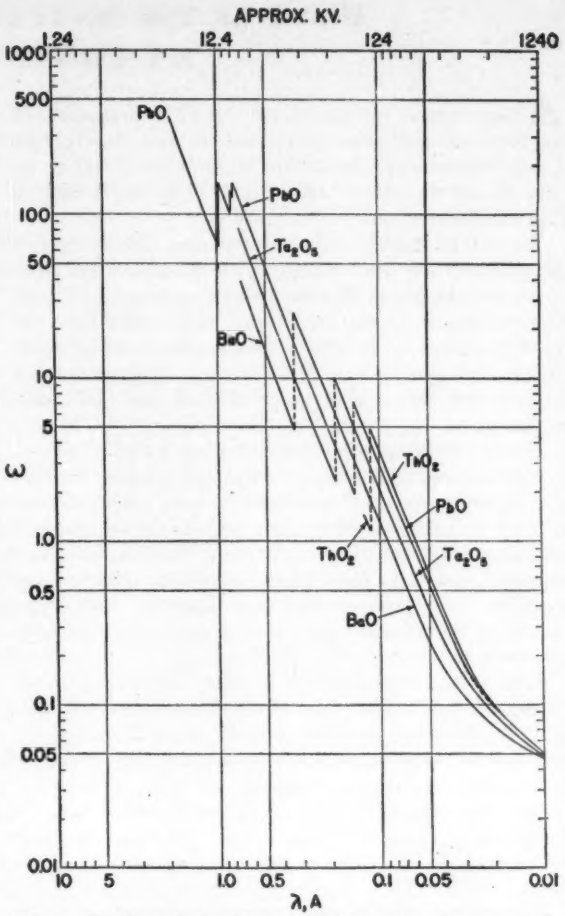


Figure 6. Mass absorption coefficient of oxides, $\omega_{M_mO_n}$, vs. wave-lengths.

components for x-ray absorbing glass can be made only after the range of wave-lengths is known and due considerations are given to the contributions of density and mass absorption coefficient of the components. The density consideration has been treated in a previous paper[2], and will not be repeated here. The following is a brief account of the variation of mass absorption coefficient with wave-length.

The K-absorption limits of uranium (Z = 92) occur at 0.1065 A. For all elements with atomic number smaller than 92, their K-absorption limits are located at wave-lengths larger than 0.1065 A. The K-limits for He (Z = 2) are at 504.2 A which is in the region of ultra-violet rays. Between the wave-length range, 0.01 — 0.1 (about 1240 — 124 KV), the mass absorption coefficient of all elements increases with the atomic number of the elements, and can be calculated from equation (7) after Victoreen. Equation (7) is still valid from 0.1 A to the individual K-absorption limits of each element. For helium, for example, the equation is valid down to 504 A. Beyond the K-absorption limits of each element, no general equation is available at present for the calculation of the mass absorption coefficient. Experimental data have to be used for each case. There are usually two values of mass absorption coefficients at K-absorption limits. The Victoreen equation yields values for

(*Continued on page* 714)

[4] M. L. Huggins and Kuan-Han Sun, "Glass Properties and Periodic Table," Jour. Amer. Ceram. Soc., 27, 13 (1944), in which the specific volume, the reverse of density, is treated.

FLAT GLASS ANTITRUST SUIT SETTLED BY CONSENT DECREE

A compromise settlement of the civil antitrust suit against nine flat glass manufacturers and the National Glass Distributors' Association was approved and a consent decree signed by Judge Frank L. Kloeb in Federal Court in Toledo, Ohio, on October 30.

Several of the defendant companies, including Libbey-Owens-Ford Glass Company, Pittsburgh Plate Glass Company, American Window Glass Company and Fourco Glass Company, were saved from being split into one-plant units but by the decree are enjoined from engaging in practices which the antitrust division claimed resulted in reducing competition in production and distributon of flat glass.

Settlement of the case came after six weeks of negotiations undertaken on suggestion of the court at the time the antitrust division completed a nine-week presentation of its case last May. The consent decree was presented to the court by Herbert A. Bergson, assistant attorney general in charge of the antitrust division, and explained in detail by Sigmund Timberg, special assistant to the attorney general and chief of the consent decree section.

Fred J. Knauer, of Cahill, Gordon, Zachry & Reindel, New York, spoke on behalf of all defendants, promising that the defendants will observe the terms of the decree and stating that they have never had any intent to monopolize the flat glass business.

He said the willingness of the antitrust division to forego "divestiture and destruction of these companies" enabled the defendants to find common ground for agreement.

The decree provides for: 1) Dissolution within 90 days of the National Glass Distributors' Association, an unincorporated group of jobbers with headquarters in Chicago. Distributors and dealers are permitted to form a new trade association of their own but under the decree manufacturers cannot contribute any financial support or take any part in such a trade association. Manufacturers are forbidden to form any association of their own for five years and are ordered not to permit any distributors or dealers to have any part in such organization, if organized later. Collection and publishing of statistics or price lists which could be used to restrict markets by allocation, fixing prices or classifying buyers, also is enjoined.

2) A ban against expansion of present companies by acquiring other plants or glass sales and distribution facilities, with some time limitations, and provision that certain defendants may acquire such businesses only with express approval of the court.

3) Abrogation of arrangements with foreign glass manufacturers so far as they affect the domestic markets, and placing of securities of foreign companies in hands of a trustee named by the court for voting purposes.

4) Broadening of competition through making available to the public 187 flat glass patents on a royalty-free basis and licensing of 733 other flat glass patents, and any issued in the next five years, on a reasonable royalty basis. All infringement claims or suits are eliminated. Fifteen specific agreements, including some cross-licensing of patents in the industry, are terminated. On the distribution side, the order directs Libbey-Owens-Ford and Pittsburgh Plate to increase their distributor outlets by not less than 10 per cent over the recent average within the next four years.

Judge Kloeb inquired about the method of arriving at the 10 per cent distributor increase and Mr. Timberg explained that some injunctive provisions are "speculative" but it was thought well to have a minimum commitment on the part of defendant companies. Mr. Timberg said that the plan further provides retention of jurisdiction in Judge Kloeb's court so that after three years the court could be requested to consider further relief including divestiture.

Defendants consenting to the judgment include Libbey-Owens-Ford Glass Company, Toledo; Pittsburgh Plate Glass Company, Pittsburgh; American Window Glass Company, Pittsburgh; Fourco Glass Company, Clarksburg, W. Va.; Franklin Glass Corporation, Butler, Pa.; Rolland Glass Company, Clarksburg, W. Va.; American Securit Company, Corning, N. Y.; Blue Ridge Glass Corporation, Kingsport, Tenn., and the National Glass Distributors' Association, Chicago. Corning Glass Works earlier agreed to a separate consent decree.

The suit was filed May 23, 1945. Defendants were preparing to put their side into the record early in 1949 if the agreement had not been reached.

PHILIPS FEATURES NEW RESEARCH EQUIPMENT AT METAL EXPOSITION

A new high intensity, water-cooled X-ray diffraction unit and a new high intensity high angle spectrometer were displayed commercially for the first time at the recent National Metal Exposition by the North American Philips Company, Inc. The improved apparatus is of value in classifying and identifying metals and alloys for grain size, orientation, effects of rolling, drawing, annealing, fatigue, ageing and other physical and chemical changes.

The new Norelco diffraction unit incorporates a new high capacity, full wave rectified high voltage generator, a new automatic control system and a modern styled control panel with kilovolt and milliampere meters, improved cooling system and new type automatic beam shutters. As many as four different diffraction cameras may be operated simultaneously on the new unit.

The Norelco 180° high intensity high angle Geiger counter X-ray spectrometer may be attached to the water cooled diffraction unit, in units of one or two. As many as three different diffraction cameras may be used with one spectrometer unit at a time.

The electronic circuits associated with the high intensity spectrometer attachment may also be used for fluorescence analysis equipment and for radio activity studies. They are housed in a steel floor cabinet and comprise a recorder, a pulse rate meter, scaling counting unit, high voltage Geiger tube supply unit and a stabilizer.

THOSE "SOLAR" HOUSES

Editor
The Glass Industry

In GLASS INDUSTRY for January, 1948, (p. 32), I reviewed the book "Your Solar House", from the point of view of its technical performance, and from the point of view of one originally trained as a civil engineer, building designer and town planner. These arguments are wholly technical, and can only be disposed of by technical refutation. None of them concerned questions of "art", of the appearance of the building, or whether I personally liked glass or liked the designs. Thus, the criticism cannot be answered by saying that there are other people who have been favorably impressed with them.

Now comes an article by John L. Cox, "The Solar House is Here to Stay", in GLASS INDUSTRY for September, 1948, page 503, which indicates that a modest number of people have been well impressed by the book, or by the idea of the solar house. It is difficult from the article to find out how many people have endorsed either, and still harder to ascertain how many of them, or if any of them, have any real experience of the subject.

Thus we are told that "By the end of June, 1948, more than 50,000 copies were in the hands of architects, builders, bankers and general readers". But a large number of these copies were given free as advertising matter or propaganda. I suspect that a majority were so placed. Mr. Cox himself indicates a ratio of 50 or even 100 to 1 in several instances. Thus the number of actual endorsers of the solar idea is vastly fewer than the distribution figures indicate. Further, there is no evidence that any appreciable number of the few people, who may have bought the book with their own cash, have thereby been sold on the idea of the solar house. Nor does such a purchase mean that they had any experience of solar heating, the problems it presents or its limitations.

Again, "The data appearing in 'Your Solar House' has behind it a study conducted at Purdue University, under the direction of Dr. F. W. Hutchinson, professor of Mechanical Engineering", but Dr. Hutchinson's more detailed published reports seem to indicate clearly that there is usually very little indeed to be gained by an attempt to substitute solar heat for artificial heat. As I understand it, only a small fraction of the coal or oil bill can be saved in most parts of the U.S.A., and sometimes none can be saved. This seems to be tacitly, or half-openly, admitted in the book itself, which book virtually admits the failure of the solar principle, as I mentioned in my review, and substitutes as *chief* purpose the principles of "uniting interiors with the out-of-doors."

This is not a solar principle at all. Yet Mr. Cox, early in his discussion, says "During the first half of 1948 more than 75% of the single family residences pictured or discussed—in leading architectural journals—have been of the solar type *or of designs employing unusually large areas* of glass," (italics mine). He therein admits the distinction, that these are *not* solar houses: they are not intended as sun-traps, or coal-savers. They are "California type" houses, which occupied a large fraction of the space of leading architectural journals in this country, and even in Italy, long before this dubious notion of solar heating came up, and certainly before "Your Solar House" was compiled. It would perhaps have been better if Mr. Cox had given his estimate of the percentage of solar houses alone: it might be much less than 75%: but even if it were high, the journals *ought* to devote a disproportionate space to a novelty as against a well-ingrained tradition, even though the novelty may prove ephemeral.

The proper use of glass in houses is a most important subject: it is important to GLASS INDUSTRY, to L-O-F and to myself. More relevant is its great importance to the American householder. Mr. Cox's concluding sentence (p. 529) reads: the building of increasing numbers of solar houses "will have the inevitable effect of increasing greatly the amount of glass used in each residential unit". As I see it, the increase in the amount of glass is likely enough even if the solar principle is abandoned; indeed, it may increase faster if the principle *is* frankly abandoned and the big windows turned away from the sun.

A sun-trap is very often a most uncomfortable place. In Toledo itself, one very unfortunate example was accidentally constructed by Owens-Illinois for its research laboratory on Westwood Avenue. This was not intended as a "solar house", but was made with glass block exterior walls. Although the main facade faces west rather than south, the thru-put of radiant solar energy was almost enough to barbecue the inhabitants, who wished the walls were made of anything but glass. In our own laboratories at Butler, although we were careful to make our chief offices face north or northeast, we perforce had one office facing south, with a porch-roof screening the window from direct summer insolation. In the summer it is comfortable, but in the winter it becomes a "solar house", and on a sunny winter day it can be very unpleasant. We find people moving their desks to escape incident radiation.

Thus it seems clear to me that "Your Solar House", apart from its very second-rate presentation of the evidence and of the argument for solar houses, is dealing with a fundamentally difficult and unsound proposal. The proposal to use the solar energy as a direct means of heating, though seemingly tempting, runs into very great practical difficulties and disadvantages with which the book does not deal adequately. We may sympathize with L-O-F's ambition to sell more glass, but cannot automatically admit that "forty sash and door concerns", for instance, by their enthusiasm for the book, have solved the problems.

I expect to see the solar house, as such, have a very limited acceptance; but this does not apply to those houses that use large amounts of glass in a more practical fashion.

F. W. Preston

• E. M. Ford, President of Wyandotte Chemicals Corporation, has announced the acquisition of the manufacturing facilities and clay deposits of Blue Mountain Clay Company, Inc.

GLASS MELTING

By GEORGE E. HOWARD

Consulting Engineer, Butler, Pa.

PART II

In our foregoing presentation of this general subject, the main thesis was directed to the need of a new conceptional approach to the subject. Specifically, it was to show that the old basis was largely historical and traditional, that it was more concerned with a fixed structural concept than with functional factors: That such a basis necessarily limited the scope of engineering and caused the trend of research toward the discovery of cause and cure for numerous inherent ills; That the imposition of a fixed structural basis in turn prevents the elimination of ills and encourages the use of palliatives for reducing effects of, rather than cures for deep seated functional ills.

We are now going further and will question the generally accepted theory that glass is best made by finely grinding and mixing the balanced ingredients and maintaining a homogeneous mixture from start to finish within the limitations of the fixed structures accepted as conventional. The original glass according to tradition was not formed in this way. It was formed rather on the erosion principle whereby the more easily melted ingredients were first fused into a liquid, which then picked up by erosion sufficient quantities of the more refractory lime and silica to finally form the material we call glass.

Far be it for me to suggest that this accident on the Phoenecian desert furnished an example either of a process or a product to be emulated. It did, however, furnish a lead, and showed that glass could be made in that way.

An experience many years ago further developed this lead. A small tank producing hand blown bottles was filled at long intervals with a batch consisting of 3000# of sand to which were added the lime and soda thought proper for the final product. The tank was allowed to drop its level during the 18 hours shift then prevalent, and made up by excess filling during the balance of the time which was during the night. The teaser who also weighed and mixed the batch was somewhat under the influence of liquor one night. To his horror he found that he had failed to add the lime and soda and instead dumped the whole 3000# of sand for one fill without the necessary solvents.

This was not discovered by others until later. In the meanwhile, the glass did not suffer either in quality or quantity. The reason is quite obvious. In those days the ordinary bottle glass was made with a large per cent of soda, and a corresponding lesser per cent of silica.

The single fill of all sand undoubtedly formed a large mass in and near the doghouse and on the bottom where by erosion it gradually wore away doing no harm and probably improving the glass by bringing up the silica content to a higher per cent. One or two blowers, however, had noticed that the glass had "changed its nature" and was somewhat "harder" to work.

It is difficult to handle glass with more than 74 to 75% silica without trouble from devitrification in the finished article especially in feeders and automatic forming machines. However, glass has a limiting factor in that it can absorb only about 80% of silica. Furthermore, ordinary lime, soda glass seems to be best when it contains 74 to 76% of silica. This is not true of various other ingredients of glass, the desirable percentages of which are a small fraction of the maximum amount that can be absorbed.

Another and most important factor that must be noted in any intelligent consideration of chemical erosion is the law of absorption and saturation to use these somewhat unsatisfactory terms. This can be mentally visualized by considering the course of particles of soda. lime and silica through the melting and refining cycle.

First, the course of the finely ground batch is homogeneously mixed and this homogeneity kept throughout the cycle. Here three different particles would travel in contact and as temperatures rose, the soda would melt and form a liquid which would next unite with the lime and together would combine with the silica which is the most refractory to solution. When chemical action has been completed, gases and bubbles eliminated, there still remains a glycerine and water effect which takes a long time and much fuel to finally clear up. The grains of sand (silica) must be completely absorbed or coalesce with the liquid, in this case soda and lime by the slow process of diffusion.

Now consider the course of the batch through a similar cycle but using the erosion method which will be more specifically described later, and illustrated by sketches showing certain means for carrying out this system. Here the dissolving liquid consists of soda and lime with perhaps a fractional percentage of silica in the form of fine sand. This liquid passes through a zone of relative large silica lumps such as ganister crushed and screened perhaps to a 3" diameter size. The liquid passes over and between the intersticial spaces as do also the melting flames.

The amount of silica matrix contains much more volume and weight than the liquid. The liquid does not coalesce or dissolve any particular unit lump of silica completely but picks up additional silica in solution to the desired amount. This absorption of silica is measured by the solvent propensity of the liquid, the time and area in contact with the silica masses and the temperature. The glass or liquid will not be collected as a body until it has passed through the zone of silica lumps at which time melting and plaining have been accomplished and the resultant body of molten glass in the collector is ready for fabrication. This practically eliminates the large refining surfaces now necessary, the high temperatures are in the center of the materials, the erosion of the walls of the structure is also eliminated as the eroding agent acts on the silica lumps which are constantly replaced. All batch dust is entirely eliminated. Most im-

portant is the small amount of factory space needed and the simplicity and low cost of installation. The wear and depreciation would be a small fraction of that of the conventional tank furnace.

For each square foot of radiating surface in the melting zone of Fig. 1 there would be 12.4 square feet of heat absorbing surface, heavy insulation would be possible and low cost materials could be used as the inside wall temperatures would be lower than either the glass temperature or the flame temperature. As contrasted to this, the present conventional tank has from 5 to 8 square feet of radiating surface for each square foot of heat absorbing surface of the glass. Also the wall temperatures are high and materials costly. Furthermore, the temperatures possible are limited to the refractory limits of the construction whereas there is no particular limit to the temperature desired in the erosion type furnace. Finally, the plaining compartment could be limited to a collecting basin and would be used only for a cooling unit to bring down the temperature to the desired amount suitable for the fabricating process. The overall efficiency of heat absorption could be on the order of 70% as against the average of 16% of conventional tank melting.

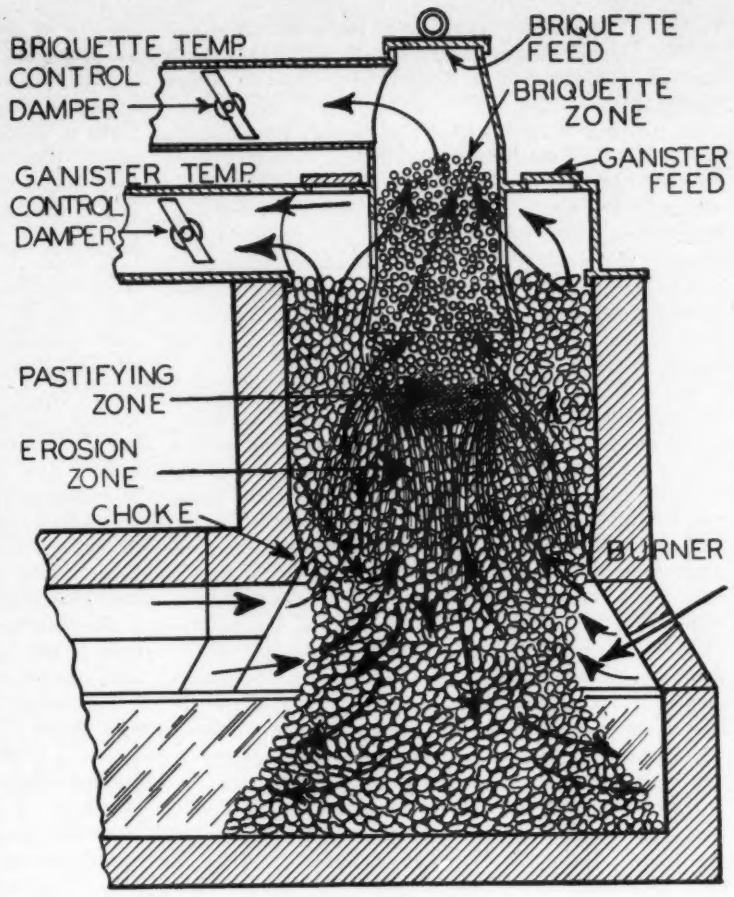


FIG. 1

The control of the glass level can be effected in several ways singly or in combination. Tonnage within the maximum limit would be measured by the amount of batch materials fed, the melting zone temperature or an overflow to insure maximum and constant metal level. Obviously, a presentation of this kind should do something beside criticize the conventional systems which, after all, have borne and continue to bear the burden and heat of the day.

Similarly, simply to offer the suggestion of a new and better process functionally as a generality, or theory without an accompanying structural example of some sort for performing these functions, would rightly condemn any presentation as futile, or at best as merely academic, usefui mainly to arouse discussion. The author is aware that up to this point the foregoing chapters are vulnerable in this respect. The following subject matter will, I trust, remove this vulnerability.

But before presenting some specific examples of structures, it should be interesting and useful to roughly sketch some historical background to show how and why this particular section of glass making (the melting process) has failed so far to get "on the beam" of evolutionary progress. In the meantime, the product itself, "glass," and the fabricating of the molten glass, have been fairly astride the evolutionary beam with accomplishments that equal the miracles of this scientific age generally.

The reasons are largely economic which, except in the barbaric propensity of the human race to revert to war, largely determine both the efforts expended and the result achieved by scientific evolution. For a long past period and until a short present period, the total tonnage and dollar value of glass was small. This small tonnage was produced by a large number of small companies, competition was fierce, sales and price structures were chaotic, and no single companies had the research or experimental resources as we now employ them. There were no adequate trade organizations to share in such expenses. Labor was cheap except for the high priced skilled glass blower. Installations especially in the table ware, window glass and container fields were low in cost. Freight rates and transportation were cheap, competitive markets were large in area. Fuel and glass making materials, while relatively cheap compared to the present time, were such a large percentage of the total that they determined the location of factories and largely accounted for the kaleidoscopic shifts in factory locations.

As natural gas was developed over a wide area, new plants followed this development. Frequently a company was offered free gas for a period of years and exemption from taxes for locating in some town or small city. This put a relative high percentage of cost on the skilled glass worker's wages and the often obitrary attitude of the unions furnished the motivation for the development of the automatic machine.

The ensuing higher cost of installation destroyed the mobility for cheap, quick transfer of plants, and consigned scores of window and container plants to scrap

heaps. At present the enormous tonnage, the rising cost of fuel, repair, and installation cost have brought the cost of melting up to a figure where it is no longer negligible.

In the path of the urge for evolutionary improvement in glass melting stands that huge Budda, the ancient tank furnace. He must not have any of his essential functions changed. The cry for a unit melting system whereby tank machine and lehr operate in co-ordination is not permitted. This Budda will give slightly more glass for a unit of fuel but only on condition that the enormous total poured into his maw is increased. Scheduling of tonnage may present difficulties but must be met to build him up bigger and bigger.

In the earlier portion of this presentation, the author attempted to show that the melting of glass, involving many different stages, could be improved by separating the units best fitted to perform these diverse stages. He assumed, but not accepted, the ancient, traditional premise that to best melt glass the ingredients must be homogeneous and maintained so. The author does not know who proposed this particular method, nor why it has been accepted so finally as a fundamental. He has vainly sought for some sound reason why it is so. He can see some very sound reasons why it is not so. He is, therefore, presenting some sketches of certain structures designed to carry out this erosion process. There are numerous other types of units available to the designing engineer some of which may be even better adapted to this process.

The particular types shown have been selected largely because they are well known, simple and in daily use in making other products. This was proposed and tried out in glass making some years ago and while my information of the results is not from direct observation, it is sufficiently authentic to establish a definite lead to the possibilities of this erosion process.

This was covered by a patent (now expired) on July 10, 1928, issued to the inventor K. Kunzel. The claims were so broad and fundamental, covering the idea of melting glass in a shaft type furnace, that no previous patent or commercial operation of this sort had been known.

The furnace was a simple vertical shaft wherein the batch materials, neither ground nor mixed, were dumped into the vertical furnace shaft and were bathed with the gases of combustion passing upwardly there through. There was glass produced of bottle quality, but neither the character of the batch materials nor the control of the products of combustion had the refinements necessary for a successful erosion method. Yet this operation proved one of the main advantages of the erosion method; viz, production of uniform glass quality.

The reason is that the erosion process automatically tends to maintain uniformity in the glass whereas the conventional tank furnace inherently tends to destroy the homogeneity of the initially mixed batch especially in the pastifying stage.

Fig. 1 shows a cross-section of a proposed shaft furnace operating on a proper erosion method. Silica in the form of coarse ganister of relatively large size (3" approx.) provides a surface of 2800 sq. ft. (Fig. 1) for heat absorption of the glass passing over and coating these silica lumps. In sketch No. 1 the diameter of shaft is 5'-6".

If a melting end of this area were used in the conventional bath method, it would have 23.3 sq. ft. of heat absorbing surface against 2800 sq. ft. of heat absorbing surface of sketch No. 1 using only 5'-0" of height for the effective heating zone. The tonnage on the basis of 4 sq. ft. per daily ton would be 5.8 tons for the conventional method against 700 daily tons for the shaft furnace. Yet the shaft furnace would occupy only about $\frac{1}{3}$ of the factory floor space and its cost would be less than 25% of a conventional melting end.

Obviously, this is a fantastic tonnage figure and takes in account only the heat absorbing surface ratio. The limit of possible tonnage, however, would be extremely high and could reach at least 100 tons daily and provide at the same time seven times the heat absorption surface even at this latter figure over the 5.8 ton limit of the conventional design.

The radiation factor would likewise be in about the same order. The conventional melting end would have 185 ft. radiating surface or an 8 to 1 ratio to melting surface whereas the shaft furnace of sketch No. 1 would have only 130 ft. of radiating surface for the 2800 sq. ft. of melting surface or a ratio of $\frac{1}{22}$ to 1. Moreover, the temperature to be insulated would be lower as the high temperature would be in the glass as opposed to the high temperature on the furnace wall in the conventional tank.

Another advantage would be that the form of the shaft melting furnace would easily and cheaply permit a tight metal outside covering eliminating stingout and air leakage which is a considerable factor in conventional tanks especially at the later period of a campaign.

A most important advantage would be the elimination of forced cooling to prevent block erosion. In sketch No. 1 it is obvious that the erosion is on the continuously

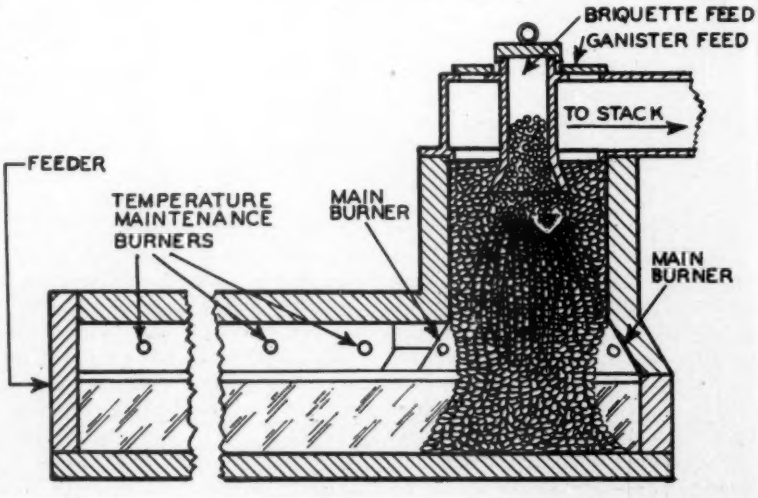


FIG. 2

renewable silica contents mainly in the center of the shaft. A sad commentary on the engineering principles employed in the modern melting end is the fact that the line of development tends toward the use of denser and more highly conducting material and extreme cooling in order to preserve the life of the blocks. This has forced the development and use of expensive high temperature refractories to withstand the high temperature required to force more heat absorption in the glass than is absorbed by the cooling walls containing the molten glass.

If we make the tank large enough, the refractories expensive enough and the volume of fuel high enough, we actually do achieve a small fuel gain as tank size and tonnage increase. But it still remains a sad engineering spectacle. If we balance the picture with the disadvantages caused by scheduling, the sales and freight problems, and the loss from idle down time, etc., the economic picture is much sadder.

The shaft furnace suggested would vary in efficiency with load but only in a relatively minor degree. With radiation practically eliminated and stack temperature entirely under engineering control for whatever figure was desired and with glass heat absorbing surface far in excess of the needs of the largest tonnage needed, the fuel efficiency of this furnace would be less variable to load and in the worst case be so much higher than in the best case for the conventional tank that a glass manufacturer could really give his attention to his business as a business and not turn it over to the dependence it now has on the necessity of a high uniform melting tonnage schedule.

As stated above the physical and chemical reactions in a properly designed erosion principle furnace are such that plaining as we now perform it is unnecessary. When glass is made by such a method, we automatically elminate bubbles, seeds, ream strings striae, glycerine and water effects and a host of other headaches inherent in the bath melting or tank system.

There is no way to form them and hence no need to eliminate them whereas in the conventional tank the batch is in a fluid body from room temperature to refining temperature and acquires these undesired factors largely for that reason. In the proposed system, the glass does not form into a liquid body until after it has been melted and plained. Before we can adequately explain this difference, we would have to obtain a considerable amount of additional research data both on the conventional method of glass melting and on this proposed erosion method.

Much of this data simply does not exist. A technical description of this sketch is not necessary for the technically trained reader certainly and the illustration shows graphically about what might be expected. The upward pointing arrows show the flame travel and the downward arrows the course of the glass.

The dampers can be operated to control the heating zone as desired. The batch or briquette feed is central and the lump silica feed is in a circular surrounding ring. The relatively small pasty liquid is merely indicated. Its extent and position are controllable. Silica lumps can be fed with briquettes, and briquettes can be fed with the silica lumps to some extent if desired or necessary to maintain proper working conditions.

The briquettes may be composed of lime, cullet and soda with some proportion of silica in the form of sand such as 40%, 60% or higher. This will produce an easy melting liquid of relatively low viscosity. The balance of required silica will be absorbed by the glass, its viscosity lowered by rising temperature and raised by added silicon percentage from solution and erosion.

The author would again repeat that like all preceding matter this is not a technical description of an ideally designed furnace. It is intended to illustrate the principles of a more progressive approach to a better evolutionary progress in glass melting.

Keeping this in mind, I would call your attention to Sketch 2, which shows the addition to Fig. 1 of a conventional tank structure into which the glass from the collecting basin underneath the melting furnace flows. Inasmuch as the glass is already plained, this is more a cooling than a heating portion and the suggested burners are for temperature maintenance mainly. The main heating burners would obviously be at the space above and surrounding the collecting basin. Sketch No. 3 shows a somewhat different design wherein the glass passing from the accumulating pools is carried through a series of pools or pots.

This latter design is principally interesting in showing a design in which convection currents and outside wall cooling are avoided. In as much as three-fourths of the furnace radiation is through tank walls and one-fourth through sides and corners, this type could be very efficient in fuel and glass quality.

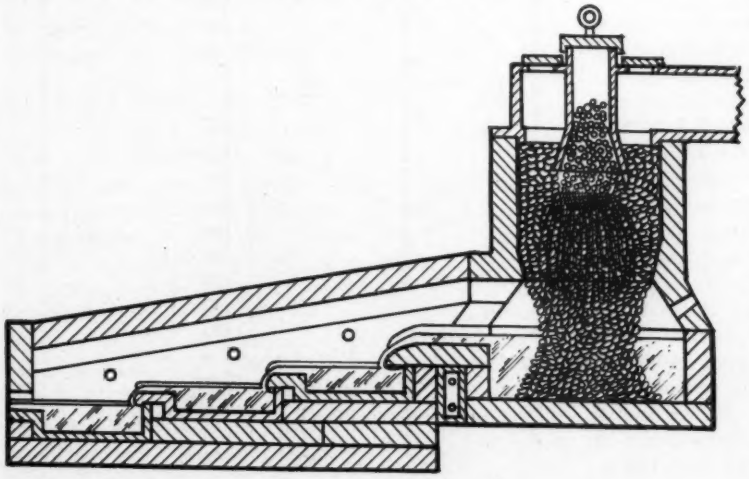


FIG. 3

To summarize the suggested erosion method of glass melting: First, select a structure that would be suitable for performing the suggested method. There are many types or styles of structure suitable for this which provide wide latitude in design. Second, provide briquettes of materials finely ground and proportioned for desired final product except that the silica content is substantially less than the amount desired in the final product. Third, arrange rela-

(*Continued on page* 722)

RECENT TRANSLATIONS OF RUSSIAN PAPERS OF INTEREST TO THE GLASS INDUSTRY

Abstracts of three papers, which appeared in the Russian journal of the glass and ceramic industries.

Carborundum Saws For Glass

The high price of diamond saws induced K. T. Bondarev to prepare and test carborundum saws, see *Stekol'naya i Keramicheskaya Promyshlennost* (Glass & Ceramic Industry) 1947, No. 1, p. 16.

Circular saws of carborundum are made by mixing coarse-grained carborundum, fine carborundum and a phenol-formaldehyde binder, molding the mixture to a disc about 300 mm. (1 foot) in diameter and 3 mm. (1¼ inch) thick, and curing under pressure. The average grain size should be low as coarse discs give rise to ragged fracture surfaces. The linear speed of rotation should not exceed 15 meters (49 feet) per sec. An intensive water cooling is essential.

The adjacent table shows a comparison between the performances of diamond and carborundum saws.

TABLE

	Diamond	*Carborundum*
Diameter of the saw.....	300–350 mm.	250–350 mm.
Thickness of the saw....	1 mm.	2–4 mm.
Linear speed of rotation.	9–13 m./sec.	10–15 m./sec.
Rate of production.....	2000–2500 cm²/hr.	2000–2500 cm²/hr.
Duration	5–8 hr.	2–3 hr.
Total production	8000–12000 cm²/hr.	4000–6000 cm²/hr.
Expenditure of diamond.	2–3 karats	–
Price of a saw.....	50 rubels	10–15 rubels.

Heat Conductance of Some Glasses

Our knowledge of the heat conductance of glass is so meager that any new data on this subject are welcome. D. B. Ginzburg recently described in *Stekol'naya i Keramicheskaya Promyshlennost* (Glass and Ceramic Industry) 1947, No. 7, p. 9 his calculations and experiments on the overall heat conductance of two glasses.

Glass A was made on a Fourcault machine and had the composition SiO_2 73.15, Na_2O 13.13, Al_2O_3 1.98, Fe_2O_3 0.30, CaO 9.00, MgO 2.44%. Glass B was a mirror glass made in a pot and contained SiO_2 72.0, Na_2O 13.5, Al_2O_3 0.5, Fe_2O_3 0.1, CaO 13.8, MgO 0.1%.

The apparatus used consisted of a water calorimeter (below) and a flame chamber (above) which were separated from each other by a plate of glass A (3.8 mm. thick) and two plates of glass B (13.8 and 12.8 mm. thick) piled on each other, A being in contact with the flame and B, with the calorimeter. A groove was made on the top surface of each of these plates, and thermocouples (platinum and platinum-rhodium) were placed in these grooves. The temperature at the boundary between the bottom plate and the calorimeter underneath it was measured by means of copper-constantan thermocouple soldered in the lid of the calorimeter. In the flame chamber, town gas mixed with compressed air or with oxygen burned giving the temperature in one experiment of 1460°C, and in another experiment, of 1020-1045°C.

The four thermocouples allowed measurement of the temperature differences Δt between the top and the bottom of every plate. The amount of heat Q passing through the plates to the calorimeter was computed from the temperature rise of the water in the calorimeter. The area of the plates, F, and their thickness, δ, were easily measurable. Thus, the apparent heat conductivity could be calculated from the equation

$$\lambda = \frac{Q\,\delta}{\Delta t.\ F}$$

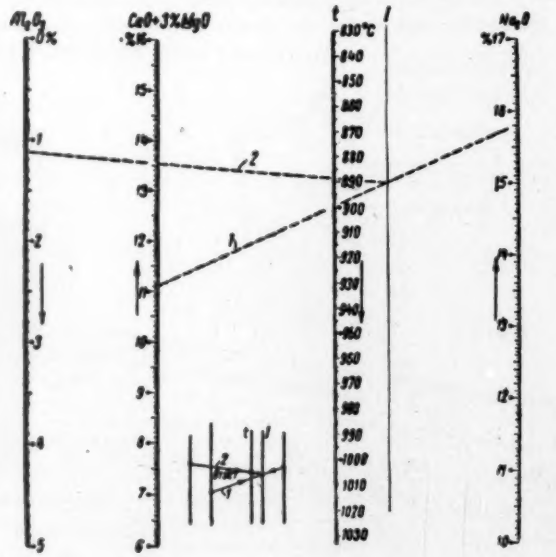
The results are combined to a table

Table

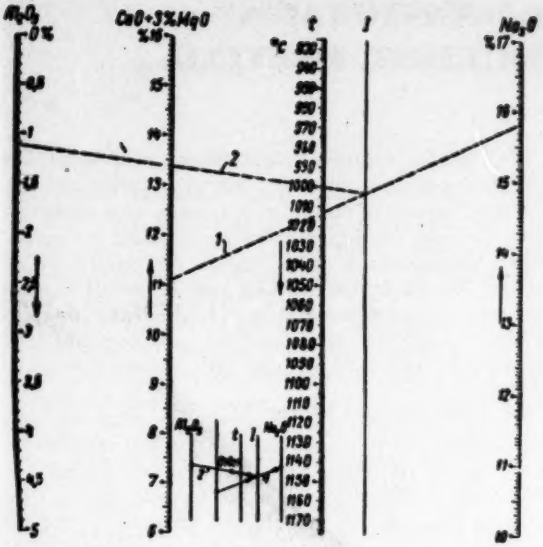
Apparent heat conductivity in cal. per meter × hour × degree °C.

	Temperature of the flame chamber			
Temperature interval	1460°C. Glass A	1460°C. Glass B	1020-1045C. Glass A	1020-1045C. Glass B
1306-1195°	2.17			
1195- 816°		2.32		
816- 130°		1.19		
826- 791°			1.75	
791- 615°				1.30
779- 620°				1.55

These data can be used for computing the heat transfer through the mass of molten glass in a glass tank. The heat conductance of glass in the above temperature range greatly exceeds that of the glass batch. An average batch compressed to the density of 1 (i.e. equal to



Nomogram 1.



Nomogram 2.

that of water) had λ of about 0.2 between 100° and 700°C.

D. B. Ginzburg points out, however, that the values listed in the Table do not represent the true heat conductivity and, contrary to the true conductivity, depend on the temperature gradients within the glass, the thickness of the glass plates and other conditions of the experiment. This is so because hot glass radiates heat which is absorbed by, and raises the temperature of, colder glass. A mathematical analysis of the complex heat transfer (i.e. by simultaneous conductance and radiation) shows that the above equation is correct only if a) the glass does not absorb any radiation, or b) the glass absorbs the radiation to such an extent that the radiation does not penetrate behind the immediate neighborhood of its source.

The values of the Table are valid only as long as there is no convection. Convection in glass tanks increases the rate of heat transfer compared with the above data.

Nomograms for the Viscosity of Glasses

M. V. Okhotin, *Stekol'naya i Keramicheskaya Promyshlennost* (Glass and Ceramic Industry) 1947, No. 11, p. 8 gives 3 nomograms for calculating the viscosity (or rather the temperature corresponding to a given viscosity) of glasses which contain SiO_2, Na_2O, CaO and may contain also MgO and Al_2O_3.

Each nomogram has 4 scales and, in addition, a supplementary line parallel to the scales. The scale at the left is for Al_2O_3 and covers the range of 0 to 5%. The next scale is for CaO + 3% MgO and covers the range of 6 to 16%, that is from 3% CaO + 3% MgO to 13% Cao + 3%MgO. If the glass does not contain any magnesia or the percentage of magnesia is different from 3, a correction is applied, see below. The third scale is that of temperatures. In nomogram 1 its limits are 830° and 1030°C.; this nomogram is for the viscosity of 100,000 poises. In nomogram 2, valid for the viscosity of 1000 poises, the temperature scale ranges from 930° to 1170°C. Nomogram 3 is designed for the viscosity of 1000 poises and has a temperature scale starting at 1070°C and ending at 1370°C. The scale at the right is for 10% to 17% Na_2O.

The use of the nomograms is explained best by examples.

1) It is asked at what temperature the viscosity of 100,000 poises is reached by a glass consisting of SiO_2 71.95, Na_2O 15.82, CaO 8.11, MgO 3.00, Al_2O_3 1.12%. First a ruler is placed to connect the point 15.82 on the Na_2O scale with the point 11.11% (because 8.11 + 3.00 = 11.11) on the scale for CaO + MgO, see discontinuous line 1 on nomogram 1. The point of intersection of this line with the supplementary line is marked. Then the ruler is placed so as to connect this point of intersection with the point 1.12 on the Al_2O_3 scale. The intersection of this line (discontinuous line 2 on nomogram 1) with the scale of the temperatures shows the temperature (889°) searched.

2) Nomogram 2 shows determination of the temperature at which the same glass as used in example 1 has the viscosity of 10000 poises. Repeating the procedure indicated above, this temperature is found to be between 1000° and 1001°C.

3) In nomogram 3, the supplementary line is left of the temperature scale but the procedure is unaltered. The determination of the temperature at which the above glass has the viscosity of 1000 poises is shown by the discontinuous lines 1 and 2. Line 1 connects 11.11 on the CaO + 3% MgO scale with 15.82 on the Na_2O scale. Line 2 passes through 1.12 on the Al_2O_3 scale and the intersection of line 1 with the supplementary line, and is extended to the temperature scale which it hits at 1167°C.

If the amount of MgO differs from 3%, the temperature found in a nomogram must be raised (if there is more than 3% of MgO) or lowered (if there is less than 3% of MgO) by 5°C for nomogram 1, 6°C for nomogram 2, and 9°C for nomogram 3 for every percent difference between the actual magnesia content and 3%.

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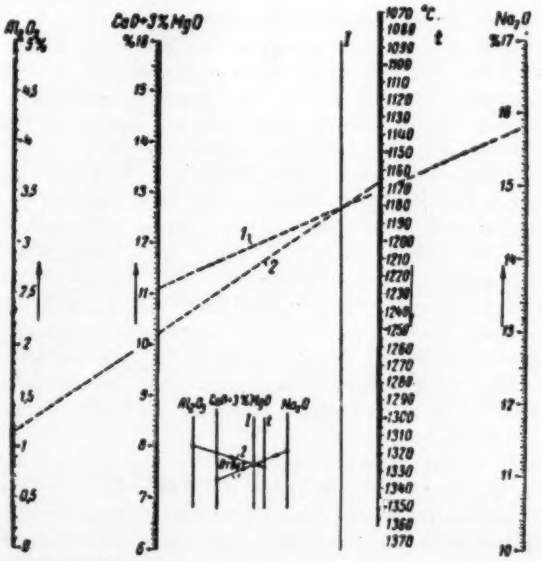


Nomogram 3.

GLASS SECTION OF NATIONAL SAFETY COUNCIL HOLDS FIRST MEETING

The campaign against carelessness in the glass and ceramics industry organized a year ago by leaders in these fields with the cooperation of the National Safety Council is beginning to get results.

Reports of progress made at the first annual meeting of the Council's new Glass and Ceramics Section held in Chicago, during the National Safety Congress, Oct. 18 to 22, revealed that substantial and growing interest is being taken by every branch of the industry in the problem of reducing accidents among employees. Both management and the workers are pitching in and pushing the project, it was indicated.

Reviewing the first year's activities of the new Council group, Fred G. Anderson, Manager of compensation and safety, Corning Glass Works, Corning, N. Y. and first Chairman of the section, revealed how the program for a concentrated attack on accidents on the job has been presented to 600 glass and ceramics manufacturers in 38 states and seven foreign countries.

In additon to promotional material designed to create understanding of the program, each of the 600 has received four issues of the section's newsletter carrying practical discussions of common industry accidents, their cause and prevention.

The section's engineering committee, Mr. Anderson said, has sent out considerable mimeographed material from National Safety Council sources bearing on accidents in the industry, while a report on occupational diseases of glass and ceramics workers has been prepared and will be released soon. One poster bearing a safety message for display in factories and mills has been put out and a second is to be ready in December.

Organized on a tentative basis a year ago to see what could be accomplished, the year's work of the new section has met with the national organization's requirements and official approval of the section has been granted. On Oct. 1 the group assumed official status as a section of the Council, he announced.

One result of the program, Mr. Anderson declared, will be an improvement in the statistical picture of the industry's accident record. He referred to discrepancies between National Safety Council figures and those of the Bureau of Labor Statistics covering accidents in glass and ceramics plants. The variations, he said, had come about because the Council did not have access to accident records of the smaller establishments. The new section, he stated, expects to establish close relations with the small companies within the industry, thereby making possible assembly of records which will reflect a truer picture of what's happening to employees. "This accident problem," he added, "needs to be given serious attention by the smaller companies. Best results can be obtained by acknowledging that there *is* a safety problem in our business."

"Too many people think of the National Safety Council as a poster factory," remarked Arthur S. Kelly, staff representative of the Council, as he presented the conference with an outline of what is available from the national organization.

It's true, he continued, that the Council distributes 4,000,000 posters a year, each bearing a safety message. But the Council, he said, also puts out a vast volume of other material, bearing on every phase of safety: promotional, administrative and technical. Originally, he explained, the Safety Council had been organized as a cooperative, non-profit association to facilitate the swapping of ideas on safety. Other functions have been added as the necessity arose and he, personally, felt very proud of results.

Mr. Kelly complained that companies often enter the organization, but never report their accident experiences, never ask for educational or other material available to them, and, in fact, leave it to the Council staff to send whatever the folks in the Chicago office fancy may be pertinent to that company's interests.

He appealed to members of the Glass and Ceramics Section not to use this approach to their accident reduction efforts. While the Council has many specialists in accident prevention, they make no pretension to knowing all the answers, he continued, and suggested that "If you write us we'll get the information you want. Sometimes we've had to go to 50 persons to get an answer but we get it. You must, however, bear in mind that many safety problems are still not satisfactorily solved."

Among the wealth of material available from the Council, Mr. Kelly mentioned a multitude of safety codes setting standards for safeguarding mechanical equipment used by industries of every type. Educational material available for supervisors of safety includes, he said, twelve pamphlets on safety in foremanship, six sound slide films and other items. Promotional material includes posters, decalcomanias, mats and statistics for creating an intelligent understanding of industrial safety principles.

Another speaker from the National Safety Council, John M. Roche, Manager of the industrial department, frankly told the Chicago conference that "For the past forty years the glass and ceramics industry has not been accused of doing too much safety work, although some improvement can be noted in the immediate past ten years.

"Then, last year," he continued, "a group of you folks who want to keep your children alive so they can carry on in the industry, sought our help in organizing this section and getting a safety program started. We suggested that you try it for a year and, viewing results, we feel that you have, thus far, done very well."

The Safety Council, however, he intimated, has hopes of still greater accomplishments by the Glass and Ceramics Section. As a suggestive goal to work for, he referred to activities of the Council's pulp and paper industry section.

"They've put out five data sheets and ten detail sheets bearing on pertinent safety problems in the pulp and paper field," he stated, "and they have drafts ready for five safe practices pamphlets. They've also enlisted the cooperation of their trade associations to spread the

(*Continued on page* 724)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Glass Wool and Fiber

Method of Drawing Fibers. Fig. 1. Patent No. 2,453,864. This invention proposes a new method of drawing glass fibers or filaments and it was assigned to Glass Fibers, Inc., of Waterville, Ohio, by Walter R. Schlehr of Toledo.

It has been found that the tensile strength of fibers is increased when the temperature of the glass to be drawn is lowered. As the temperature is reduced, it becomes more difficult to extrude the molten glass through small openings. To overcome this objection, it has been proposed to apply pressure to the glass being extruded and Everett J. Cook has a patent application now pending on this subject. This patent urges the molten glass through the orifices by gaseous pressure evolved by the glass as it melts. The patent also discloses means for supplementing this pressure from an outside source, if necessary.

In the figure, there is shown a heating crucible 10 containing molten glass 13 which is extruded through a series of small openings 12 in the bottom of the crucible. The heat for melting is supplied by a high frequency induction coil 14. A feed hopper 20 contains a supply of glass making material in the form of pellets 21 which are periodically delivered to the melting crucible by the rotation of a pair of discs 16 and 17. These discs have openings 22 and 23 which permit predetermined quantities of the pellets to be delivered while the opening remains sealed from the outside atmosphere. The discs are driven by gearing connected to a motor 26.

In order to prevent the building of too high a pressure, a relief valve 30 is provided which can be adjusted by the handle 34 to regulate the pressure in the crucible.

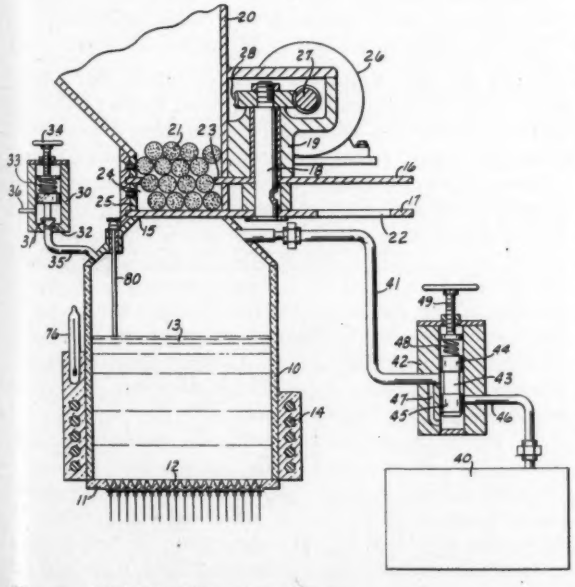


Fig. 1. Method of Drawing Fibers.

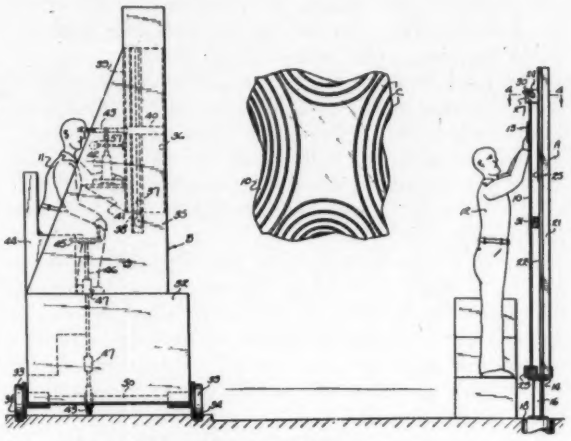


Fig. 2. Inspection of Optical Glass.

The patent names four principal factors which cooperate to determine the size of the filament being drawn. These are 1) the temperature of the glass, 2) the pressure acting to force the molten glass through the orifices, 3) the rate of drawing the fibers from the discharge sides of the orifices and 4) the size of the orifice. It has been found that to obtain a filament of a diameter of .00025", the best conditions are a glass temperature of about 2250°F., orifice size about .040", pressure on glass about equal to 10" of water and drawing rate about 10,000 feet per minute. These conditions will produce a filament having a diameter of .00025 plus or minus .00002".

One example of a batch usable under the above conditions, is:

	Per cent parts by weight
Raw dolomite $CaMg(CO_3)_2$	22.4
Raw limestone $CaCO_3$	17.4
Calcined borax $Na_2B_4O_7$	5⅓
Boric acid H_3BO_3	5⅓
Kyanite $(AlO)_2SiO_3$	23¾
Sand SiO_2	48¼

When this composition is pressed into pellets and melted, carbon dioxide will be liberated to produce the desired pressure.

An automatic valve 42 admits pressure from a source 40 in case the pressure in the crucible drops too low. The patent gives wiring diagrams for the electrical connections.

The following references are of record in the file of this patent: United States Patents: 2,159,361, Atkinson et al., May 23, 1939; 2,229,489, Barnard, Jan. 21, 1941; and 2,294,266, Barnard, Aug. 25, 1942.

Miscellaneous Processes

Inspection of Optical Glass. Fig. 2. Patent No. 2,452,364. This invention relates to the inspection of flat glass in order to determine whether it is suitable

for use as viewing windows or reflector plates used in certain instruments, such as gun sights, range finders, sextants, etc. The inventors are Ival G. Fowler and Donald W. Dunipace, who assigned it to Libbey-Owens-Ford Glass Company. Plate or window glass to be used for the above mentioned purposes must have sides which are within certain limits of parallelism. The slight angle which may occur between the two sides is known in the business as the "wedge" in the glass.

The sheet is inspected by the aid of light reflected from the front and back of the sheet while illuminated by monochromatic light. When viewed in this manner, a series of dark and light bands are seen, these being called interference fringes. The arrangement and frequency of these fringes indicates the amount of wedge in the glass.

The apparatus for practicing this invention is shown in Fig. 2 where A indicates the means for supporting the plate 10 to be inspected and B, the inspecting means. An operator 11 on the inspecting device cooperates with an operator 12 at the slate who uses a measuring device 13 to mark the areas selected by the first operator as being suitable for use.

The supporting device A is carried by cylinders 18 by which it may be raised and lowered. A black background 22 is provided by the panel 22. Various devices are provided for supporting the plate 10 securely in its frame.

The inspecting means B includes a truck 32 mounted to run on rails 34 extending parallel to the glass plate 10. The front of this truck carries a light diffusing screen 36 such as an etched glass plate, in back of which are a series of Cooper-Hewitt mercury lamps 37 which give substantially monochromatic light. By the aid of reflectors 38 and the diffusing screen, a uniform illumination of that part of the sheet 10 to be inspected is provided. A tube 40 cooperates with a telescope 43 so that the operator 11 can examine the plate 10. This operator can traverse his truck horizontally by means of a hand wheel 45 while the plate can be moved vertically by the other operator, thus providing means for inspecting the entire plate. Filters may be employed to make the light more nearly monochromatic, if desired.

As seen through the telescope 43, various interference patterns may be seen. One of these is reproduced here in the smaller part of the figure. Thus the two operators can go over the entire plate and mark the parts of it which come within the prescribed limits of wedging. These parts will be satisfactory for use in the required finished parts. A great deal of additional information can be obtained from the patent.

The following references are of record in the file of this patent: United States Patents: 536,759, Potter, Apr. 2, 1895; 674,951, Abbe, May 28, 1901; 815,859, Palis, Mar. 20, 1906; 1,332,124, Harney, Feb. 24, 1920; 1,875,665, Schwiezer, Sept. 6, 1932; 2,042,526, Hohmann, June 2, 1936; 2,047,221, Pechy, July 14, 1936; 2,239,263, Waine et al., Apr. 22, 1941; 2,253,054, Tuttle et al., Aug. 19, 1941; 2,312,888, Everest, Mar. 2, 1943; 2,337,877, Drescher, Dec. 23, 1943; and 2,338,981, Straub, Jan. 11, 1944.

Glass Sealing Device. Fig. 3. Patent No. 2,452,652. Bell Telephone Laboratories, Inc., acquired this invention from Rolf K. Hansen. The patent relates particularly to the exact positioning of the parts in the glass

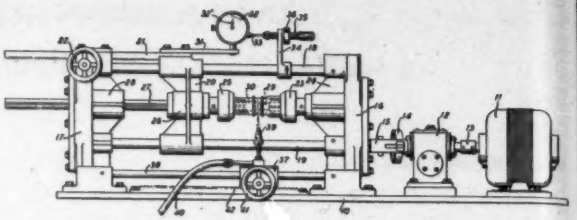


Fig. 3. Glass Sealing Device.

envelopes such as employed in ultra-high frequency electron discharge devices. The exactness required may be such as .035 inch $\pm$.002 for example.

This invention provides a sealing lathe having a pair of axially aligned chucks which are relatively movable and indicating means so that the position of the parts carried by the chucks may be easily determined. This is shown in Fig. 3 where a base 10 carries a motor 11 connected through a reduction gear 12 to drive a chuck 23. Another chuck 25 is mounted on the end of a shaft 27 which slides in a journal 28. This shaft is carried by a carriage 20 riding on rails 18 and 19. The carriage 20 and chuck 25 are movable to and from the chuck 23 by means of a hand wheel 22 connected by a gear with a rack 21 fixed to the carriage 20.

Also projecting from the carriage 20 is an arm 31 having a micrometer dial 32 on the outer end in position to be actuated by an adjustable plunger 33 which is in fixed relation to the chuck 23 so that the exact relative position between the two chucks and the parts carried thereby may be readily observed. The lower part of the lathe has a carriage 37 sliding on rails 38 along which it is moved by a hand wheel 41 connected to a rack 42. A burner 39 on this carriage serves to heat the glass parts to be joined.

This invention provides a method and mechanism for splice sealing sections of a glass vessel so as to insure accurate spaced relation between the grid surfaces thus increasing production and saving loss from improper spacing of the parts.

The following references are of record in the file of this patent: United States Patents: 1,486,968, Kempton, Mar. 18, 1924 and 2,271,658, Miller, Feb. 3, 1942.

Glass Bending Apparatus. Fig. 4. Patent No. 2,452,488. This is the invention of Ormond H. Paddock and John P. Pearse who assigned it to the Libbey-Owens-Ford Glass Company. It has been usual to bend glass by supporting it over a concave mold and then heating it until it softens and settles into the mold. The sheet thus heated was hotter in some places than in others due to the lens action of the concave mold. The results were not perfectly satisfactory. This invention secures a uniform heating of the sheet and a better bending by retarding the heating of certain parts of the sheet by shielding it from the direct heat and at the same time increasing the heating of other parts of the sheet by reflection from certain polished parts of the mold.

In Fig. 4, there is shown a furnace 10 having sides 11 and 12 and an arch 13. The furnace may be heated by radiant heating tubes 14. A concave bending mold 16 is mounted on a truck 15 which travels on rails 18 by means of wheels 17. The sheet 20 to be bent is supported above the mold by inclined wings 21 and 22 which are beveled at 23 so as to cooperate smoothly with

the side edge 24 of the mold. The wings are mounted for pivotal adjustment about bolts 26 attached to vertical straps 27, the mounting being such that the wings 21 and 22 can be adjusted vertically, horizontally and angularly.

When the glass is heated to the softening point, the edges slide down on the wings and the sheet assumes the shape of the mold as shown in dotted lines at 20'. A recessed area 32 is formed on the upper surface of the mold, this area being about the size of the finished curved sheet desired. The use of such a recess gives a much better surface to the bent sheet.

The distribution of heat to the glass sheet is regulated by a shield 33 mounted on supports 34 so its distance above the sheet may be adjusted to regulate the amount of heating. This, of course, retards the heating of the central portion of the sheet. The heating of the side portions of the sheet may be accelerated by reflective strips 40 and 41 which may be formed by painting, plating or otherwise so as to present a surface reflecting more heat than the relatively dull surface of the mold 16. It will be understood that the size and position of the shield 33 and the reflecting surfaces 40 and 41 must be adapted to the work being done.

The following references are of record in the file of this patent: United States Patents: 280,143, De Voursney, June 26, 1883; 760,959, Commington, May 24, 1904; 1,857,540, Hardenberg, May 10, 1932; 1,889,881, Thompson, Dec. 6, 1932; 1,999,558, Black, Apr. 30, 1935; 2,009,748, Sherwood, July 30, 1935; 2,176,999, Miller, Oct. 24, 1939; 2,213,406, Paddock et al., Sept. 3, 1940; 2,215,228, Oliver, Sept. 17, 1940; 2,218,254, Wengel, Oct. 15, 1940; 2,244,715, Long, June 10, 1941; 2,314,812, Blau et al., Mar. 23, 1943; and 2,348,278, Boyles et al., May 9, 1944. Foreign Patents: 180,627, Switzerland, Feb. 1, 1936 and 112,340, Austria, Jan. 14, 1941.

Sheet and Plate Glass

Sheet Handling Device. Fig. 5. Patent No. 2,452,392. This invention was assigned to Libbey-Owens-Ford Glass Company by William A. Philbin of Perrysburg, Ohio. It is usual to store plate glass sheets in a "bank" or place for dead storage before taking them to the grinding and polishing machines so that production will not have to stop in case of failure of the grinding machines and vice versa. Heretofore it has been necessary to move

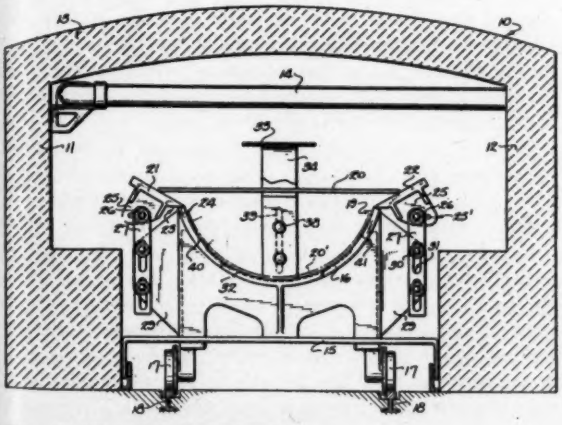


Fig. 4. Glass Bending Apparatus.

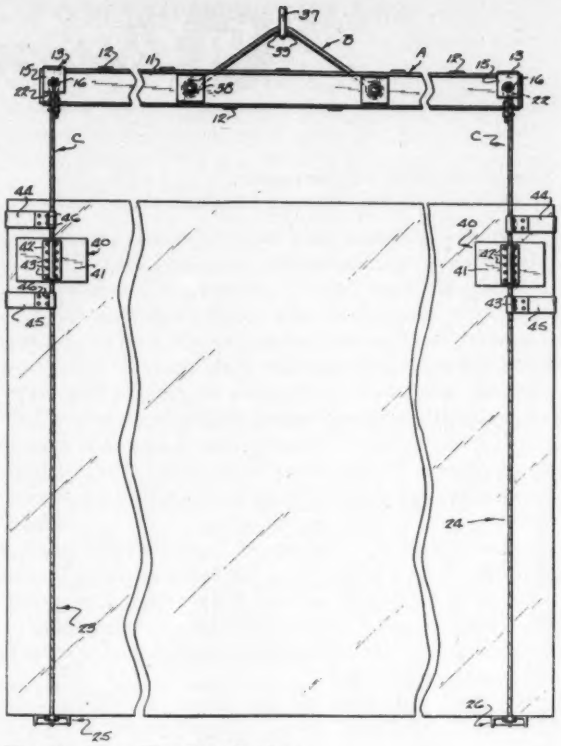


Fig. 5. Sheet Handling Device.

sheets to and from the A buck and the bank, one at a time. These sheets or blanks may weigh as much as 350 to 750 pounds and this was a difficult and dangerous job.

This invention provides a lifting and transporting device which can pick up a whole group of blanks which may weigh as much as 9 tons. The drawing shows this device as comprising a yoke A, a bail B and a pair of slings C. The yoke is made from a pair of channel irons 11 held together by spacers 12.

At the ends of the yoke there are brackets 13 having depending sides which carry bolts 16 to which are attached cables forming the loops 23 and 24 for supporting platforms 25 and 26 upon which the blanks rest. The top surfaces of the platforms are covered with some non-scratching material so that the blanks will not be damaged. The yoke A is suspended by a hook 37 which engages the bail B and is positioned by lugs 39. The loops are each provided with cushioning members 40 which prevent damage to the blanks and also hold them firmly in position. In order to insure that the blanks cannot slide lengthwise from the loops, straps 44 and 45 connect the sides of each loop.

The manner of use and the utility of this device will be clearly apparent to those familiar with the business.

The following references are of record in the file of this patent: United States Patents: 379,870, Hohorst, Mar. 20, 1888; 541,120, Root, June 18, 1895; 1,436,151, Carstarphen, Nov. 21, 1922; 1,522,707, Andrews et al., Jan. 13, 1924; and 2,131,406, Mosmieri et al., Sept. 27, 1938. Foreign Patents: 525,948, Great Britain, Sept. 6, 1940.

• The appointment of Clarkson Hill as director of accounting and cost planning for the glass division of Pittsburgh Plate Glass Company has been announced.

GI Research Digest

The Mechanism of Corrosion of Refractory Materials by Molten Glass

Numerous methods have been suggested for assessing the resistance of a refractory material to corrosion but in nearly all cases there is considerable difficulty in accurately relating the results so obtained to actual performance. K. E. Seal *(Journal of the Society of Glass Technology*, February, 1948) feels that, at the present time, the safest method of test is by trial of the refractory material in the structure during operation of the glass melting furnace. This has been the basic procedure in his present investigation, an attempt being made to develop an hypothesis of the mechanism of corrosion from the petrological examination of the refractories after service. For this purpose, representative samples from the various positions in the furnace structure were taken so as to include all the different types of refractory attack by glass, vapor and batch. The methods of examination of the specimens employed were visual, x-ray and petrographic.

The results obtained on the various specimens were as follows: 1) *Crown drops.* Drops from both crowns of tank and pot furnace were found to consist entirely of silica and glass, the latter being green in color, cordy and containing particles (approximately spherical in shape) of the original silica brick. These particles when less than 1mm. in diameter were composed of spherulitic cristobalite. On the outside of the larger particles, a layer of hexagonal cristobalite, 0.4mm. thick, covered the core of original material. 2) *The sidewalls.* These showed the shot-blasting effect of entrained batch dust in the flame. Little surface slagging occurred. At the hot face, cristobalite had replaced the original tridymite. There was also an indication of an increase in average size of the cristobalite from that of the original tridymite. 3) *Drops hanging from the port lining.* The original fire brick in the crown of the port lining had an alumina content of 42-44 per cent. The drops varied in length from ¼ in. to over 1 in. and when fractured showed concentric bands varying in color from cream at the center to reddish-brown at the surface. The results of an x-ray examination of these colored bands are given in Table I.

TABLE I

Description of sample	Cryst. phases found	
Cream layer from center.....	Mullite	80%
	Corundum	20%
Fawn intermediate layer.....	Mullite only	
Brown material from underside..	Mullite	30%
of outer layer.....	Corundum	70%
Reddish-brown material from surface	Ferric Oxide	60%
	Hercynite	40%

4) *The slagged outer surface of covered pots.* These specimens had zones similar to those of drops from port linings changing from a dark brown glazed surface to a white porcelain-like layer before reaching the main body of the pot. The extreme outer surface of the pot showed surface crystallization of mullite, confined mostly to areas where iron-stained glass was present. Below this zone for about 0.5mm., the layer was almost entirely of glass except for a limited amount of mullite around holes in the glass. The transition from this glassy layer to the main body of the pot was gradual as the saturation of this glassy phase with mullite and dissolving refractory proceeded progressively. Within the transition layer, it was interesting to note first, the increase in size of mullite crystals when in the presence of iron-stained glass and, secondly, the appearance of two more iron-bearing minerals.

5) *The tuckstones.* If made of silica, the tuckstones can be considered as a continuation of the sidewalls. The fire clay tuckstones (40% alumina) showed a loosely-bonded crystalline network at the surface of the hot face consisting of large corundum plates, together with a complex feldspar type mineral. A section perpendicular to this face showed at the cool portion, mullite, tridymite and cristobalite. The "grey layer" was largely composed of interlocking mullite needles set in a siliceous glassy matrix. As the hot face was approached, there was a substantial increase in the amount of glassy matrix, together with an increase in the size, up to approximately three times those originally present, of loose mullite needles. This progressive increase in size continued until corundum became dominant when the proportion of mullite rapidly decreased until it became non-existent.

6) *The tank block.* a) Above the fluxline. The slagged surface was similar though less massive to the tuckstone previously described. b) At the fluxline. There was little difference between this specimen and that above the fluxline except that there was a considerable decrease in the thickness of the surface glassy layer. This reduction in thickness is probably due to the smaller proportion of crystalline material present which was a indication of the severe erosion experienced at this position due to current in the glass. c) Below the fluxline. A section made across some of the eroded grooved areas showed no increase in the crystal size of the mullite, the only disintegration being brought about by the removal by the glass of unchanged refractory particles. These individual masses were entirely composed of interlocking mullite needles with little glassy phase.

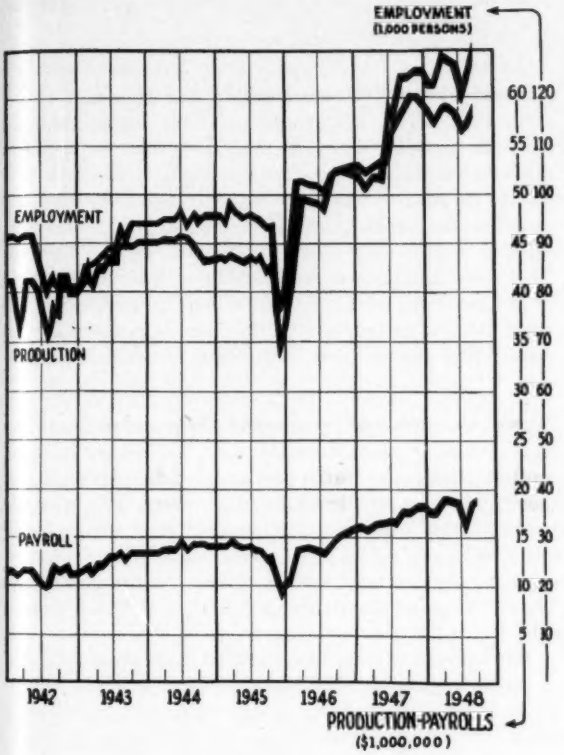
7) *The throat block.* The throat and cover blocks were fusion-cast "Corhart." After use, they were covered with pink plate crystals (corundum) embedded in a white, crystalline matrix (nephelite). No mullite was detected in the interlayer between glass and refractory.

From these examinations, three main factors affecting the resistance of refractories to corrosion seem to be of greatest importance. They are 1) The increase in the amount of the glassy matrix present as the working face is approached. 2) The growth in size of mullite crystals brought about by vapor penetration. 3) The growth

(*Continued on page* 718)

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



According to the Production Index for the month of September 1948, activity in the glass industry increased close to 4 per cent to reach an estimated figure of $67,000,000. The August figure was $64,500,000. During the month of September 1947, production was estimated to be $63,500,000, which is 5½ per cent below September this year. At the close of the third quarter of 1948, total estimated production had reached $569,300,000, as compared with $528,000,000 at the close of the same period in 1947.

Employment and payrolls: Employment during the month of September 1948 was 118,600. This is an increase of 2½ per cent above the 115,600 reported for the previous month. During September 1947, employment was 118,600, which is the same as that reported for September 1948.

Payrolls during September 1948 increased slightly more than 3½ per cent to reach an estimated $18,500,000, as compared with the $18,000,000 reported for August. During September 1947, glass manufacturers paid out an estimated $18,000,000—a difference of about 3½ per cent. Total estimated payrolls at the close of the January-September 1948 period has reached $150,250,000, as compared with $148,500,000 paid out during the corresponding period in 1947.

Glass container production, based on figures released by the Bureau of Census, reached a total of 9,107,323 gross during the month of October 1948. This figure represents an increase of about 4 per cent over the 8,711,910 gross produced during the preceding month. Production during October 1947 was 9,642,974 gross, or about 5 per cent above October this year. Total glass container production thus far in 1948 has reached 84,685,337 gross, as compared with 98,907,720 gross produced during the corresponding period in 1947. This represents a difference of about 14 per cent.

During October 1948, shipments dropped about 19 per cent from the 10,442,430 gross reported for September to 8,457,337 gross. Shipments during October 1947 were 9,165,875 gross, or 7 per cent above October this year. Total shipments made during the first ten months of

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

Narrow Neck Containers	October 1948
Foods	1,112,293
Medicinal & Health Supplies	1,036,650
Chemical, Household & Industrials	567,557
Beverages, Returnable	454,999
Beverages, Non-returnable	.....
Beer, Returnable	177,400
Beer, Non-returnable	320,685
Liquors	844,584
Wines	264,318
Toiletries & Cosmetics	501,480
Sub-total (Narrow)	5,279,966
Wide Mouth Containers	
Foods	2,037,308
Dairy Products	293,138
Home Canning	24,922
Medicinal & Health Supplies	267,962
Chemical, Household & Industrials	94,118
Toiletries & Cosmetics	164,465
Packers' Tumblers	118,393
Sub-total (Wide)	3,000,207
Total Domestic	8,280,272
Export Shipments	177,065
Total Shipments	8,457,337

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production October 1948	*Stocks October* 1948
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries and Cosmetics	Narrow Neck	3,432,617	2,567,507
	Wide Mouth	2,739,692	1,883,249
Dairy Products		337,338	243,503
Home Canning		*128,790	552,228
Beverages, Returnable		528,306	726,181
Beverages, Non-returnable		.....	.....
Beer, Returnable		153,975	671,686
Beer, Non-returnable		333,327	265,670
Liquors		1,010,547	561,311
Wines		324,991	240,485
Packers' Tumblers		117,740	82,745
Total		9,107,323	7,794,565

*This figure represents Fruit Jars only.

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1948 are 84,195,107 gross, as compared with 98,906,720 gross shipped during the same months in 1947—a difference of 14 per cent.

Stocks on hand at the close of October 1948 are 7,794,565 gross, as compared with 7,246,472 gross on hand the preceding month and 7,890,375 gross on hand at the close of October 1947.

Automatic tumbler production for the month of October 1948 was 5,859,237 dozens. This represents a 26 per cent increase over the 4,635,814 dozens produced during October. During October 1947, production was 5,833,445 dozens. Shipments for October 1948 were 5,436,493, or close to 8 per cent above the 5,038,378 dozens shipped during September. Shipments during October 1947 were 5,185,586 dozens. Stocks on hand at the close of October 1948 were 7,150,161 dozens, as compared with 6,987,412 dozens on hand at the close of September and 8,868,549 dozens on hand at the close of October 1947.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware rose to 25 per cent for the month of October 1948 to a reported 4,242,277 dozens. The previous month's sales were 3,401,822 dozens. Sales during October 1947 were 4,510,709 dozens. Total manufacturers' sales for the 12-month period ending October 1948 were 42,580,689 dozens, as compared with 40,219,776 dozens sold during the corresponding period in 1947.

The figures for automatic tumbler production and sales of table, kitchen and household glassware of one manufacturer are estimated due to this company's inability to meet THE GLASS INDUSTRY's deadline. However, the totals for this concern have been estimated in order to complete the compilation of total industry figures. These total figures will be adjusted in the next issue of THE GLASS INDUSTRY.

Plate glass: The recent consent decree settling the flat glass antitrust suit which was originally brought to trial in Federal District Court in Toledo, Ohio, provides, among other things, that the defendant manufacturers may not collect and publish statistics. As a result of this order, the figures which have been a part of this department for several years giving monthly industry totals of plate glass production in square feet do not appear this month.

VITRO MANUFACTURING APPOINTMENT

The Vitro Manufacturing Company has announced the appointment of Theodore Lenchner as director of Market Research and Advertising.

Mr. Lenchner, well-known in the ceramic field, was among the first to reproduce colors previously purchased abroad and to make possible their manufacture on a commercial scale in this country.

Mr. Lenchner became associated with Vitro in 1932 as sales and service representative, and held the position of service manager at the time of his present appointment.

L-O-F EXECUTIVES HOLD INFORMAL MEETING WITH LABOR LEADERS

Continued cooperation in productivity to maintain quality of product and high wages was pledged at an informal dinner meeting of Libbey-Owens-Ford Glass Company executives, plant managers and personnel managers with the international officers, district presidents and local heads of the Federation of Glass, Ceramic & Silica Sand Workers of America, CIO, in LaSalle, Illinois, recently.

The dinner marked the conclusion of a two-day session which brought the Ottawa, Illinois, plant management and supervisory group together with company executives the first day and the company management and labor leaders the second day.

John D. Biggers, President of L-O-F, told the group that promotion work on more extensive use of glass in stores, homes and automobiles over a period of years is now coming to fruition and will probably result in a substantial increase in dollar volume of glass sold next year. Economic facts of the glass business covering the last seven years were presented by Mr. Biggers in chart form.

At the labor-management dinner, Sylvester Garrett of Philadelphia, labor relations coordinator in the industry, and Dr. E. H. van Delden, Industrial Relations Director of L-O-F, each commented on the maturity in the bargaining relationships, leadership and pride in maintaining sound labor-management relations.

KIMBLE AT WORK ON DEVELOPMENT OF ALL-GLASS BULB FOR TELEVISION

A 16-inch, direct-view all-glass bulb for television receivers is being developed by Kimble Glass Division of Owens-Illinois Glass Company, according to an announce- by Stanley J. McGiveran, General Manager of the Division. Mr. McGiveran stated that production was expected to start early in 1949.

The glass bulb, according to the announcement, will present a televised picture more than two and one-half times as large as the 10-inch bulb, the development of which was considered revolutionary in glass making less than a year ago.

Production of the 16-inch bulb, Mr. McGiveran continued, will require engineering developments beyond those now used in television bulb making and will be made possible by new manufacturing methods.

"Glass, in our opinion, is the most suitable material, even for such large bulbs," Mr. McGiveran said. "Our experience in sealing glass to metal over large sealing areas has never been too satisfactory."

Mr. McGiveran further stated that the development and make-ready costs for the production of this new bulb are substantial, but the long-range price of the all-glass bulb should be lower than the price of bulbs made of a combination of substitute materials. He estimated that no more than 10 per cent of the television sets made during 1949 would use the new 16-inch direct-view bulb.

• Paul D. Japp, former New York District Manager for the Pittsburgh Corning Corporation, has been named Manager of Sales Promotion for the corporation with headquarters at the general offices in Pittsburgh.

BOOK REVIEW

Cobalt

(American Chemical Society Monograph No. 108)

By Roland S. Young, Ph. D.

This new monograph on cobalt is one of a series sponsored by the American Chemical Society and has been written for two classes of readers: 1) The chemist or other scientific worker who has occasion to work with cobalt and wants accurate, up-to-date and complete information; 2) The chemist or metallurgist who wishes to browse through this field in the hope of adding to his general knowledge or picking up ideas which may be applicable to his own sphere of work.

In general, the glass technologist and the ceramist are in the first classification as far as this monograph is concerned as only one chapter out of the thirteen deals directly with their field of interest. This is the chapter on cobalt compounds in the glass and ceramic industries and in which the author successfully covers and briefly summarizes the existing meager theoretical and practical knowledge concerning cobalt and its use in glasses, enamel, pottery and glazes.

Other chapters which are of secondary interest to the glass technologist and the ceramist include Chapter 1, Historical and General; Chapter 2, Occurrence of Cobalt; Chapter 4, Chemical Properties of Cobalt; and Chapter 13, Analysis of Cobalt. Other chapters in the monograph deal with the metallurgy of cobalt, the physical and mechanical properties of cobalt, cobalt in ferrous alloys, in non-ferrous alloys, in powder metallurgy, electroplating of cobalt, catalytic behavior of cobalt and the biological and biochemical relationships of cobalt.

The author is the Chief Research Chemist of Rhokana Corporation, Ltd., Nehanga Consolidated Copper Mines, Ltd. and Rhodesia Broken Hill Development Company, Ltd. To this glass-minded reviewer, he has done an excellent job of assembling the widely scattered information regarding cobalt and its diversified uses in the 181 pages which make up the monograph.

Published by Reinhold Publishing Corporation, 330 West 42nd Street, New York, N. Y. Price $5.00.

W. Ronald Lester

NEW REGULATIONS ON HEARINGS FOR TARIFF CHANGES

It has been reported that the State Department, in connection with the extension of the Trade Agreements Act by Congress last June, has decided to continue the Committee for Reciprocity Information as a means of collecting information about any tariff change. In addition, the Tariff Commission must now hold hearings as directed by the new law. The result is that there are now two hearings instead of one on any contemplated tariff change.

It is expected that there will be new trade agreement negotiations with several countries and that glass will be mentioned in them.

• The date for the second Pacific Chemical Exposition by the California Section of the American Chemical Society for 1949 has been set for November 1 through 5 at the San Francisco Civic Auditorium.

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GLASS NEWS IN CANADA

Hobbs Glass Ltd., London, Ont., affiliate of Pittsburgh Plate Glass Co., and recent buyer of industrial buildings on 2½ acres of Toronto harbor front, has also purchased buildings west of the site, formerly occupied by Toronto Shipbuilding Co. This brings the company's waterfront holdings to approximately six acres, including factory buildings with 77,000 sq. ft. of floor, docks and slips with a frontage of about 1,000 ft., with the company planning to expand and consolidate holdings.

Fiberglas Co. of Canada will shortly light furnaces and launch test runs in its new plant at Sarnia, Ont., with the company pushing for production in December. With an expected 200 workers and 24-hour-day operation, the plant will make glass "wool" for insulation and textiles, using mainly soda ash and silica sand. Building and outside installations are completed and rigging of final-process equipment is being rushed.

Though extensive trenching and possibly core-drilling may be essential, a 55 feet bed of quartz sand near Peace River in the Alberta area of Canada appears about ready to be called a "find" of commercial importance, with fuller exploration of the deposit expected to prove much of its bulk suitable for glassmaking.

The Research Council in Alberta has called this a "promising sand bed" and it has forecast detailed geological, as well as development, surveys to determine its extent, uniformity of the sandstone, depth of overburden, costs of mining and purification as silica sand. "Since sand for glass must be brought into the province from the United States, the finding of a major deposit of suitable sand would be of the utmost importance," the Council observes.

A patent has been granted in Ottawa to John Ross Taylor, Westmount, Quebec, Canada, No. 444,331, for the manufacture of soda ash.

It has been described as follows: A method of producing soda ash which comprises passing brine successively through a series of chambers, ammoniating the brine in each chamber by spraying a portion of a body of brine liquor into a stream of ammonia-containing gas to cause absorption of ammonia and provide a gas-liquor mixture entraining said gas-liquor mixture with another portion of said body of liquor to cause more intimate admixture and absorption of ammonia, and returning the intimate admixture to the body of liquor at a point below the level thereof, carbonating the ammoniated brine by passing the latter through a second series of chambers and successively pumping under low pressure a stream of carbon dioxide gases through the brine in each of said chambers in counter-current flow to the brine, agitating the brine in each of the last-mentioned chambers to prevent scale formation therein, filtering the carbonated liquor to separate the sodium bicarbonate therefrom, and calcining the sodium bicarbonate to convert it into sodium carbonate, carbon dioxide and water. Claims allowed, 3.

• Flex-O-Lite Manufacturing Corporation recently purchased about 13 acres of vacant ground for the site of a new manufacturing plant.

Part of the property has a frontage of 1100 feet on the St. Louis-San Francisco Railroad. The company manufactures reflective glass beads for use on painted highway and airfield strips, as well as on stop signs, etc.

NEW EQUIPMENT AND SUPPLIES

NEW FURNACE ATMOSPHERE INDICATOR

Charles Engelhard, Inc., 850 Passaic Avenue, East Newark, N. J., has developed a new instrument to indicate the relative oxidizing or reducing conditions of the atmosphere within a furnace, metal heat treating oven, etc. The instrument utilizes the combined physical properties of the mixed gases occurring in the combustion of fuel in such a manner that an empirical indication is obtained free from ambiguous indications.

In this new instrument, the bases are continuously analyzed in such a way that a complete record or indication of the furnace conditions during an entire run is furnished automatically on a suitable electrical indicator or recorder. Each gaseous component of combustion contributes to the final reading approximately proportionate to its relative oxidizing or reducing effect. For example, oxygen causes a strong indication to the oxidizing side, while on the other hand carbon dioxide, carbon monoxide, methane, hydrogen, etc., cause deflections to the reducing side of the scale to an extent comparable with their common reducing potentialities and their concentrations.

The instrument does not require any adjustments once put into use. The normal furnace controls are operated in the usual manner. When the results prove ideal, the reading of the Engelhard indicator then establishes the correct operating point at which subsequent heats can be duplicated. If a more oxidizing or more reducing atmosphere is desired, the operator is guided by the furnace atmosphere indicator in setting the furnace controls. The indicator will show the direction of the atmospheric change within a furnace in a positive manner without fear of encountering indications which heretofore on the thermal conductivity method of analysis have sometimes been misleading.

THERMAL-CONDUCTIVITY GAS ANALYZER DEVELOPED

Bailey Meter Company, Cleveland, Ohio, has recently expanded its line of automatic gas analyzers and recorders to include a thermal-conductivity type gas analyzer which works on the standard principle of thermal-conductivity gas analysis which measures the rate at which heat is conducted by the gas being sampled.

The new analyzer is mounted in an explosion-proof case and is unaffected by voltage variations, ambient temperature and variations in sample pressure.

BUBBLER METER

Fischer & Porter Company, Hatboro, Pa., has announced a new purge service flowmeter by which gas or liquid purge rates are measured in familiar flow units, i.e., cubic feet per hour of air or gallons per hour of water.

The "bubbler type" purge meter is an adaptation of the Flowrator instrument that includes a built-in needle valve for close control of purge rates. It covers the range of measurement generally accepted as standard for bubbler installations. The unit consists simply of a Pyrex or stainless steel ball-shaped float, a precision-bore Pyrex metering tube and a die-cast body which houses the needle-type control valve.

TECHTMANN HOOK-'N-HAUL TRUCK

Techtmann Industries, 714 West Wisconsin Avenue, Milwaukee 1, Wisconsin, has announced its new Hook-'N-Haul truck for tote boxes, cases, boxes, etc. The double-hook feature enables the hook-arm to bite into totally closed wood boxes or cases, or into open boxes, while the upper hook takes hold of handles on metal tote boxes, etc.

While the load is hooked, the operator merely pulls backward and the load slides onto the balanced tilting carrier plate. Bulky boxes can be tumbled onto the carrier plate. To discharge, a slight push with the hook-arm overbalances the carrier plate and allows the load to slide gently to the floor.

The tilting carrier plate is constructed of parallel steel plates and is balanced so the forward movement of the hook-arm places it in loading position. In pulling position or when a load is being hauled, the carrier plate is automatically tilted back off the floor.

CATALOGUES RECEIVED

Automatic Temperature Control Co., Inc., 5212 Pulaski Avenue, Philadelphia 44, Pa., has announced the publication of an 8-page catalogue, R-10, giving detailed engineering and application data covering the new ATC instrument system "Atcotran."

The booklet features pressure measurements electrically transmitted with accuracies of ¼ of 1% of reading (not total scale range) on indicator or recorder type instruments. Schematic sketches illustrate applications to all basic processing and measurements of numerous variables, such as density, flow, weight, etc.

Brown Instrument Company, Philadelphia 44, Pa., has issued a new catalogue entitled "Pressure and Vacuum Gauges" which features complete descriptions of the various instruments the company produces.

Also featured in this Catalogue #7000 are pressure actuating elements, high vacuum gauges, control components, etc. The catalogue is well illustrated throughout its 31 pages with schematic drawings, photographs and diagrams and also includes pressure range charts and indicating scales.

Process Control Division of the Richardson Scale Company, Clifton, New Jersey, has just issued a bulletin describing a wide range of applications of its automatic electrical process controls designed to solve the problems of coordinating operations of feeding, weighing, conveying, mixing and delivering.

Dealing primarily with the problem and solution by automatic control of large scale foundry operations, the bulletin also illustrates master panels, designed and installed by Richardson, which are controlling processes in proportioning ingredients for glass, plastics, electrodes for production of aluminum, pharmaceuticals, rubber tires, distilled products and asbestos shingles.

Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pa., has announced a 32-page illustrated catalogue which lists, for the first time in one publication, their complete line of strip-chart Micromax recorders and controllers for measuring a wide variety of process variables: temperature, speed, gas analysis, electrolytic conductivity, pH, etc.

Entitled "Micromax Model S—Indicating Recorders and Controllers," the publication gives complete specifications in convenient tabular form. Among the indicating recorders are single-point, two-point and multiple-point instruments which measure the values detected by one or as many as 18 primary elements. Among the recording controllers are those which provide two-position control or are integral parts of full proportional control system. Suggested chart numbers are also listed for the most commonly used ranges, together with other Model S accessories and supplies.

Barrett-Cravens Company, 4609 S. Western Blvd., Chicago 9, Illinois, has just released Junior Catalogue 487 which is the tenth edition of this pocket-size catalogue.

The catalogue contains illustrations and information on the entire Barrett line of materials handling equipment, including hand, hydraulic and electric lift trucks, pallet trucks, hoists, elevators, portable crane, storage racks, etc.

Hauck Manufacturing Company, 124-136 Tenth Street, Brooklyn 15, N. Y., has issued Catalogue 408 featuring Hauck combination proportioning oil and gas burners.

The booklet includes cut-away illustrations of burning oil and burning gas installations, automatic control data, burner accessories, burner capacities, dimensions of combination burners, etc.

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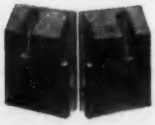
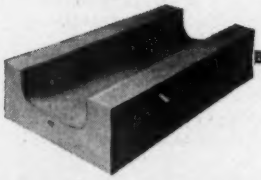
Retain shape longer for continued, more accurate control of glass gob.

BONUS-BUILDING ORIFICE RINGS—Retain shape and size for longer runs without costly replacement shutdowns.



BONUS-BUILDING BURNER BLOCK—Accuracy of dimension for quick, hairline matching to burners.



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NPA ISSUES REPORT ON L-O-F LABOR RELATIONS

The trend in the labor relations of mass production industries may be indicated by the example of progress toward industrial peace described in a report recently issued by the NPA Committee on the Causes of Industrial Peace Under Collective Bargaining. This report on Libbey-Owens-Ford Glass Company and the Federation of Glass, Ceramic and Silica Sand Workers of America (CIO) is the second in a series of Case Studies of good labor relations scheduled by the NPA Committee.

The analysis of the 15-year relationship between L-O-F and the Glass Workers demonstrates the NPA Committee's contention that "constructive industrial peace can be achieved in American business when companies and unions cooperate intelligently where their interests are in common and compromise intelligently where their interests are in conflict".

G.E. X-RAY PHOTOMETER USED TO CONTROL NATURAL GAS ODOR

A General Electric x-ray photometer, originally designed to measure the tetraethyl lead content of gasoline, is now being used to control the amount of unpleasant odor introduced into natural gas, according to an announcement by that company.

By using an x-ray photometer, the amount of "smell" emitted by the gas is being controlled by the Standard Oil Company of California. The smell comes from sulphur compounds chemically known as mercaptans, it has been discovered. According to Standard Oil engineers, a small quantity of correctly balanced mercaptan in a room is sufficient for quick identification. Mercaptans with too little sulphur, however, are unnoticeable, while those with excessive sulphur are intolerable. The engineers pointed out that the x-ray photometer finds a valuable application in controlling this sulphur content of mercaptans.

FELLOWSHIP STUDENTS AT UNIVERSITY OF ILLINOIS

A review of the holders of Industrial and Graduate College Fellowships and the work they are now engaged in has been released by the University of Illinois, Department of Ceramic Engineering. These are as follows:

Jay E. Comeforo, who holds the Illinois Clay Products Company Fellowship, is now engaged in a study of wettability and corrosion by slags of some fire clay refractories. James A. Crookston, holder of the A. P. Green Fellowship in refractories, is studying the effect of alkalies on fireclays.

William D. Fitzpatrick holds the American Refractories Institute Fellowship and will select a refractories study. William A. Graff, who holds the Owens-Illinois Glass Company Fellowship, is studying the heat transfer in glass batches. Holder of the Orton Foundation Fellowship, James H. Healy, is making an investigation of enamel smelter refractories.

Tung-Sheng Yen is studying the role of titania in fireclay refractory systems on a Graduate College Fellowship, and Harold G. Sowman, holder of the Titanium Alloy Company Fellowship, is studying the ZrO_2-TiO_2-SiO_2 system.

GLASS Bottles
FOR
over 30 years GLASS BOTTLES
OF EVERY SIZE AND SHAPE
HAVE BEEN CONTINUOUSLY AND
SUCCESSFULLY MANUFACTURED
WITH DEPENDABLE
DIAMOND
SODA ASH
DIAMOND
ALKALI
COMPANY

ENGINEERED GLASS . . .
(*Continued from page* 683)

pot furnaces consist of one 12-pot and one 16-pot regenerative type furnace. All furnaces are fired with natural gas with stand-by oil equipment available. The pot furnaces are equipped with Askania automatic pressure and draft control.

Since most of the production at this plant consists of small run lots, each pot in the furnaces may contain a different type of glass. Pot capacities range from 600 lbs. to one ton. The press shop working in one pot may be making a green railroad signal lens while at the next pot the shop may be pressing blue filter glasses, and at a third pot a blow show may be turning out red globes for airway beacons. Careful planning and scheduling is necessary to ensure that each shop has facilities available for each required step in the production process.

Fifteen presses are in use on the floor, thirteen of which are hand operated, and two of which are air operated. A modern blower system is used for cooling the men, molds and glass. A well equipped air compressor system supplies the power presses and the glass blowers.

Annealing and Heat Treating

Annealing of the ware produced in the furnace room is done in three, 3-door Amsler Morton, 8 foot automatic lehrs, all of which are 70 feet long. The lehrs are fired with natural gas.

For subsequent heat-treatment of certain products, two additional lehrs are employed. One is an Amsler Morton muffle type continuous lehr fired with natural gas and the other is a Surface Combustion continuous radiant tube lehr. Both of these lehrs are equipped with special facilities so that they may be used to satisfy the many varieties of heat-treatment methods employed by this plant. Brown thermostatic controls and recording equipment are used.

Finishing

Because of the hundreds of special items manufactured at this plant, many types of finishing operations are employed. Some of the products require the standard types of chipping, cracking-off and grinding operations; others are sliced with diamond saws and many are precision ground on Blanchard diamond surface grinders. Two of these Blanchard grinders are now in full time operation and are giving excellent service. Many items require polished surfaces and adequate equipment is maintained for this work. Dimensional accuracy of 0.002 in. is not unusual in this type of finishing. Still other products require color spraying, sandblasting and special machine marking. Modern equipment is maintained for such work.

Inspection

The inspection and testing of Kopp products is of such vital importance that constant supervision over this department is a major responsibility of the engineering department. Separate equipment is used by the inspection department much of which parallels that used in the physical laboratory.

Systematic inspection procedure is carried on from the time the ware is first made until it is ready to be shipped. In the final inspection, operations equipment of many kinds is used including photometers, color comparators, beam checking devices, polariscopes, all types of gauges, including a dial gauge which checks variations as small as one-thousandth of an inch. Thermal shock resistance is checked by plunging hot specimens in ice water.

Signal glass must in particular pass stringent tests and in many items not only must test samples be checked, but every item of the lot must pass a complete series of tests. Thus, by constantly checking and rechecking properties of the product, engineered glass is produced.

Kopp Glass is under the management of C. J. Huot, President; F. S. Huot, Vice President and General Manager; Grant Curry, Treasurer; G. D. Hammond, Secretary; and James L. Newton, Sales Manager. As previously mentioned, Dr. C. E. Leberknight is Director of Research, and E. C. Ostrander is glass chemist.

NEW SECTION OF A.C.S. TO BE ORGANIZED

A meeting is scheduled to be held on December 10 at the Farragut Hotel, Knoxville, Tennessee, for the purpose of organizing a new local section of the American Ceramic Society and to enable the ceramists in the Southeast to become acquainted with each other. The main speaker at this meeting will be Professor John W. Whittemore, President of the Society.

All interested persons are invited to attend the meeting and are asked to be prepared to name the section, select the geographical boundaries and elect officers. For those interested in joining the local section, it should be noted that membership in the national Society is not required. The only qualification is that of interest in ceramics.

Further information can be obtained by writing to Mr. Murray A. Schwartz, Fairchild Engine and Airplane Corporation, P. O. Box 415, Oak Ridge, Tennessee.

WAGE INCREASE GRANTED ALKALINE SALT WORKERS UNION

An 11-cents-an-hour across the board wage increase has been granted to members of the Alkaline Salt Workers Union, Local 414, at the Trona plant of American Potash & Chemical Corporation.

The new wage rates, effective December 1, were embodied in a two-year contract with the union, an affiliate of the CIO International Union of Mine, Mill & Smelter Workers. The agreement provides for one reopening on the subject of wages after one year.

• Open House for members of the trade and friends was recently held at the York Mirror and Glass Company, York, Pa. Approximately fifty guests from the glass and furniture fields made a complete tour of the modern mirror processing and glass fabricating shop, including the recently completed plant addition.

UNION PACIFIC

The Governor of Nevada *invites You*

STATE OF NEVADA
EXECUTIVE CHAMBER
CARSON CITY

VAIL PITTMAN
GOVERNOR

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Contributing factors are:

1. Cheap hydro-electric energy
2. Raw materials, with emphasis on live-stock and minerals (metallic and non-metallic)
3. Other natural resources
4. Favorable labor conditions because of friendly relationships between industry, management and labor
5. Ideal climate and exceptionally favorable working conditions
6. Nevada's tax structure:
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   - No Income Tax
   - No Sales Tax
   - No Tax on Intangibles
7. Unsurpassed transportation facilities and close proximity to water transportation.

I respectfully suggest that you investigate the opportunities and advantages Nevada offers industry for investment and expansion.

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Vail Pittman
Governor

Vail Pittman

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UNION PACIFIC RAILROAD

Road of the Daily Streamliners

(*Continued from page* 691)

the upper one. For the lower value, we have arrived at an empirical relationship as shown in equation (15):

$$\omega_{K,\ \text{lower}} = 200\lambda_K^{3/2}$$

where the wave length of the K-absorption limits is expressed in A.

For wave-length smaller than 0.01 (energy larger than 1.2 mev.), we come to the γ-ray region. In this region, the absorption of radiations due to Compton scattering and photoelectric effect becomes increasingly smaller; but that due to nuclear reactions such as nuclear photodisintegration and particularly pair production (creation of a pair of electron and positron) becomes predominantly larger as the energy of the γ-rays increases. Figure 7 gives a plot of the absorption coefficients of lead against the energy of γ-rays which is typical of all materials or elements. As such data are not available experimentally for all elements at present, a general survey of the subject is not advisable. However, it is safe to say that the mass absorption coefficient increases as the atomic number of the absorber increases, since pair production, which is largely responsible for the absorption in this region, increases with the atomic number through a complicated relationship[5].

As mentioned previously, the absorption of the x-rays of any material or glass of unit thickness is a function of (a) the mass absorption coefficients of the components, (b) the weight fractions of the components and (c) the density of the glass. The first obvious attempt in making an x-ray absorbing glass would be to make a pure PbO or other heavy oxide glass, since it has high mass absorption coefficient and high density. But unfortunately, PbO or other heavy oxides do not form a glass under ordinary laboratory techniques known today. From our present knowledge of glass formation, an oxide glass is not formed unless a glass forming element, such as B, Si, P, Ge, As, etc., is present in such an amount that the relative ratio of O atoms to these elements are within the limit of 1.5 to about 5.5*. The lower limit is due to pure B_2O_3. For SiO_2 and GeO_2, the lower limits are 2, and for P_2O_5 and As_2O_3, 2.5. Glass made from the pure glass formers is useless for x-ray absorbing purposes because of their low values of mass absorption coefficients. Heavy oxides, such as PbO, must be introduced to increase the mass absorption coefficient and density of the resulting glass. As the introduction of other oxides increases the ratio of O atoms to the glass forming element, there is a limit where glass ceases to form on further introduction of these heavy oxides. This upper limit is about 5.5 for the ratio of O atom to the glass forming element. This limits how far one could go in designing an x-ray or γ-ray absorbing glass.

Among the most important glass formers, GeO_2 is the best for x-ray absorbing purpose, because it has high mass absorption coefficient and density contribution. However, since weight fractions of the heavy components are also a contributing factor in the absorption, B_2O_3 is

[5] B. Rossi and K. Greisen, "Cosmic-Ray Theory," Reviews of Modern Physics, *13*, 240 (1941).

* See footnote on page 688.

[6] Kuan-Han Sun, "Beryllium in Glass," Glass Ind., *24*, 155 (1943).

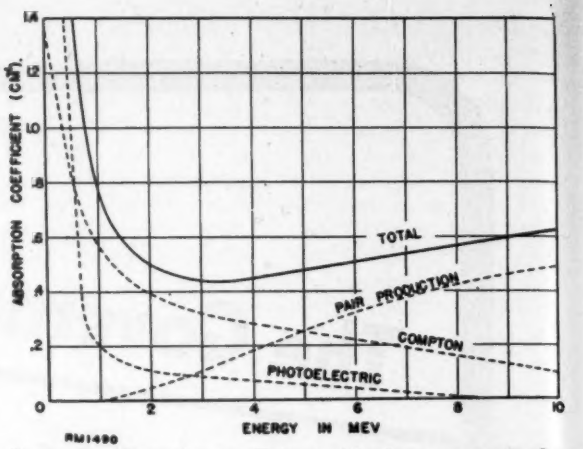


Figure 7. Absorption coefficient of lead vs. energy in the γ-ray region.

particularly useful. Because of its excellent fluxing property and low formular weight, it allows higher weight fractions of heavy oxides to be present in borate glasses. P_2O_5 is also good in its fluxing nature but suffers from its relatively high formula weight. It is interesting to note that the weight fractions instead of atomic or mole fractions play the important role here in the consideration of x-ray glasses. This is to be distinguished from general correlation of property-composition relationships, where the atomic or mole fractions are always preferred.

Thus far, we have discussed only the x-ray absorbing glass. For x-ray transmitting type, the case is reversed. Instead of using components which contribute high mass absorption coefficient and high density, those which contribute the low values should be considered. A glance at Table III suggests the adoption of components such as Li_2O, Na_2O, BeO, B_2O_3, SiO_2, etc. Figures 3 and 4 also reveal that B_2O_3 is the best glass former for x-ray transmitting purpose. A glass composed of Li_2O, BeO and B_2O_3 was suggested as early as 1907 for the transmission of x-rays. Glasses of this type have been reviewed by one of the authors[6]. However, for transmitting short wave-length x-rays, glasses of this type are not necessarily the best. In Table V, we have compared

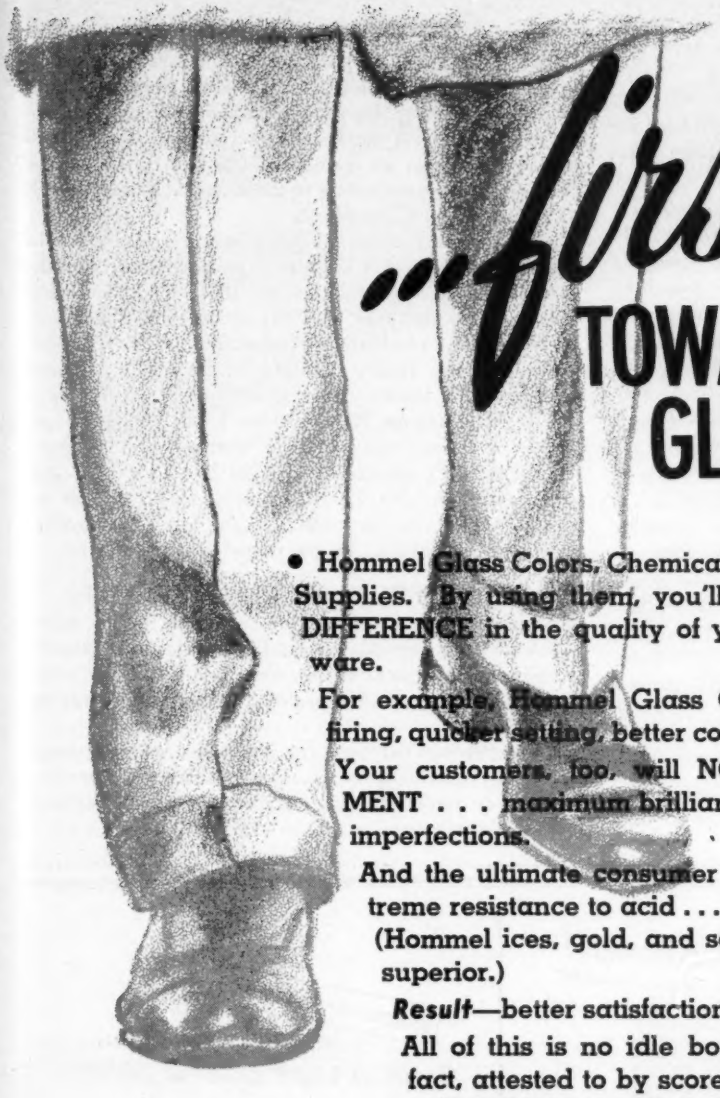
TABLE V

A Comparison of Two Typical X-Ray Transmitting Glasses

Glass Compositions in weight percentage				Density	Mass Abs. Coef.	Absorp-t'n Coef.	Reference
Li_2O	BeO	B_2O_3	SiO_2		0.1 A	0.1 A	
15	10	75	62.5	2.235	0.138	0.308	6
		37.5		2.026	0.146	0.296	7

the absorption coefficients of two glasses at 0.1 A wavelength. The one in the B_2O_3-SiO_2 system has smaller absorption coefficient than that of the one in the Li_2O-BeO-B_2O_3 system, owing to the smaller density value of the former. Since the absorption coefficient is composed of two factors: density and mass absorption coefficient, it is to be noted that while the contribution due

(*Continued on page* 716)



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Our Technical Staff and Samples are available to you without obligation. Let us help you with your problems.

World's Most Complete Ceramic Supplier

X-RAY ABSORBING AND TRANSMITTING GLASSES . . .

(*Continued from page* 714)

to mass absorption coefficient is more noticeable for long wave-lengths, the density shows more predominate effect in the short wave-length region.

It is interesting to note that B_2O_3 is again a valuable and almost indispensable component in this respect. In later articles, we shall again point out the specially valuable nature of boron oxide in neutron absorbing glasses and high refraction index optical glasses.

In addition to the above considerations, an x-ray absorbing or transmitting glass should be durable against weathering. Although we have a certain empirical concept on the contribution of durability to glass of various components, a semi-quantitative guide in this respect is very much needed not only for the present purpose, but also for all new glasses to be developed.

In conclusion, we may state that with the guidance of the above principle and discussions, x-ray absorbing or transmitting glasses superior than those now available may be developed. A recent paper on "New Glasses for Absorption of Harmful Radiations," by Rothermel, Sun and Silverman[8] seems to justify the above conclusion. We hope the present paper will stimulate further work on this field.

---

[7] G. W. Morey, The Properties of Glass, page 372, Reinhold Publishing Corp., New York. 1938.

[8] J. J. Rothermel, Kuan-Han Sun and Alexander Silverman, "New Glasses for Absorption of Harmful Radiations," to be read in the 50th Anniversary Meeting of the American Ceramic Society, April 27, 1948. Chicago, Ill.

CANADA GLASS REPORTS

Canadian imports of glass and glassware dropped to merely $1,862,000 during September compared with $2,016,000 during the same month a year ago and totalled only $19,447,000 for the first nine months of 1948 ending September as against $22,037,000 in the similar period last year, according to the External Trade Branch of the Canadian Government.

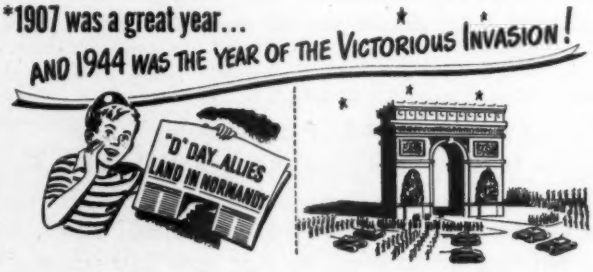
The wholesale prices of glass and its products sold in Canada advanced to 118.4 in September this year compared with 113.4 in August and 108.7 in September a year ago, on the base of 1926 equals 100, the Prices Branch of the Canadian Government reports.

The average hourly earnings in the glass products manufacturing industry rose to 89.3 cents on August 1 this year as against 85.6 on July 1 and 76.7 cents on August 1 a year ago, with the average weekly wages in this industry advancing to $39.02 on August 1 this year compared with $36.81 on July 1 and $33.59 on August 1 last year, according to the latest nation-wide survey of the industry by the Canadian Government.

MISSISSIPPI GLASS STOCK REPORT

Mississippi Glass Company, in its report to its stockholders, has announced that sales for the nine months period ended September 30 were $6,688,289 as compared with sales of $5,841,668 for the corresponding period in 1947.

Estimated net earnings for the three quarters were $514,605, equivalent to $3.11 per share of Common Stock after preferred dividend requirements, compared to $3.09 for the same period in 1947.



June 6, 1944, was "D" Day . . . Northern France was invaded by Allied forces. Later, Southern France was invaded . . . Belgium and Holland were liberated. United States troops entered Paris . . . the Siegfried Line was broken into Germany . . . the Nazis tried their last counter offensive at the Battle of the Bulge.

In 1944, Banner Lime was aiding the war effort as an essential material, supplied to the essential war industries—agriculture, building, glass and steel. Today, Banner Lime is being produced in greater quantities than ever before to help meet the ever-increasing demands from these basic industries and for the many unusual new applications and uses that are developing for this high magnesium lime.

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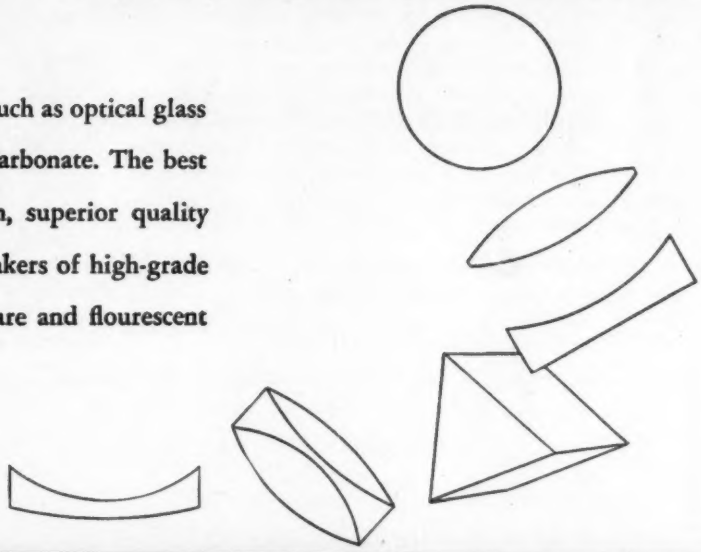

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RESEARCH DIGEST . . .
(*Continued from page* 704)

in size of mullite crystals due to the presence of impurities in the original refractory.

After a discussion of these three factors, it was concluded that when a refractory material is composed of mullite crystals above a certain size, there will be a decrease in its resistance to corrosion by molten glass. If, however, it comprises a network of small crystals bonded with a minimum amount of glass matrix, its resistance will be high by virtue of its tightly interlocking nature. Unfortunately, it has not proved possible to determine the optimum size of mullite crystals necessary to give the maximum resistance to attack. Further work along this line is necessary. It is highly stressed that impurities likely to lead either to a marked increase in the amount of glass matrix or to the promotion of the growth of mullite should be vigorously avoided in the choice of raw materials. In the latter case, iron oxide was found to act as a powerful promoter of mullite growth, especially when in the ferrous state.

It is obvious that the penetration of refractories by alkaline vapors at and above the glass line is dependent not only on their porosity but also on their permeability and in order to combat any increase in the amount of glassy matrix formed by this penetration and reaction, it is desirable to reduce the permeability to a minimum.

• T. Spencer Shore has been elected President of The Eagle-Picher Company and will assume office on January 1, 1949. Joel M. Bowlby, who has been president since 1941, was elected chairman of the board.

EMPLOYEE INSURANCE BENEFITS AT DRAKENFELD COMPANY

The B. F. Drakenfeld & Company, Inc., has adopted a group insurance program for its employees, according to an announcement by Scott J. Courtney, President. The plan is a mutual undertaking by the employer and employees, with the latter contributing fixed amounts through monthly deductions from their salary and the employer bearing the balance of the net cost.

The program, underwritten by the Metropolitan Life Insurance Company, consists of a monthly income benefit to be paid to the employees upon the date of their retirement. The distribution of pamphlets on health conservation and accident prevention has also been included in the program.

AMERICAN WINDOW GLASS NAMES SUPERINTENDENT OF OKMULGEE PLANT

The appointment of Stephen J. Resek as superintendent of the new factory of the American Window Glass Company at Okmulgee, Oklahoma, has been announced by A. S. Crandon, President. The plant has been under construction for the past year and it is hoped that one melting furnace will be in operation by the end of this year.

Starting at the company's Arnold, Pa., factory as a laborer in 1920, Mr. Resek became foreman of the gas producers in 1923, foreman in the glass drawing room in 1938, chief production foreman in 1943 and assistant superintendent in 1944.

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G.C.M.I. HOLDS SEMI-ANNUAL MEETING IN CHICAGO . . .
(*Continued from page* 685)

has been circularized to the industry by the Committee but is still too fragmentary to be significant. The U. S. Customs Court rendered a decision favorable to the industry in the case of Griffon Importing Co. vs. the United States by ruling that certain bottles imported from England were not produced "automatically" but "otherwise" and therefore required a 75 percent ad valorem duty instead of 25 percent.

The Committee reported that imports of tin were believed to be augmenting the government's stockpile, but that tin, tin plate and tin foil, materials of great concern to the closure and glass container industries, remain under allocation and use control by the Department of Commerce under authority granted by Congress until June 30, 1949.

The Committee is conferring with the Bureau of Mines on ways by which research into such fields as coal gasification and synthetic fuels can be utilized to advantage by the glass container industry.

A highlight of the afternoon session was a speech delivered by William Simon, General Counsel of the Subcommittee on Trade Policies of the U. S. Senate. He discussed "The Implications of the Supreme Court's Decision in the Cement Institute Case."

Immediately following was the report of the Committee on Market Research and Promotion delivered by its Chairman, I. J. Collins, of Anchor Hocking Glass Corp. The Committee's chief activity has been the promotion of the 1-Way Beer Bottle.

Four advertising campaigns were launched in August, covering respectively: 1) Baltimore-Washington; 2) Northern New Jersey; 3) West Coast; and 4) the nation via Sunday magazine. The advertising is supported by trade journal advertising, and store display and promotional pieces. It was inaugurated with luncheon meetings in 19 cities at which glass container executives brought together key executives of brewers, distributors and leading retail outlets. Recent consumer surveys show that sales of 1-Way Beer Bottles are now three times the national average in Los Angeles and twice the average in Baltimore.

Having thus, with limited funds, demonstrated successfully the sales possibilities of the 1-Way Beer Bottle, the Committee is developing plans for a more aggressive program of advertising and merchandising for 1949. Already three brewers are currently using large space newspaper advertising in which the 1-Way Beer Bottle is featured: Trommer in New York and Gunther and Valley Forge in Washington.

The Committee has also made preliminary studies with respect to other problems, including milk bottles, baby food containers and bottles for glass-packed food. Funds have been appropriated for a research program on milk bottles and for experimental advertising on glass-packed baby food.

• A gift of $50,000 toward the building of a new Rossford public library has been made by Libbey-Owens-Ford Glass Company in commemoration of the 50th anniversary of the establishment of the former Edward Ford Plate Glass Company in Rossford.

BORAX

When included as a minor constituent in the container batch formula will justify its addition in improvements in the melting, fining, and forming operations as well as impart beneficial properties to the finished container.

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Our representatives are prepared to discuss the special advantages of B_2O_3 in glass.

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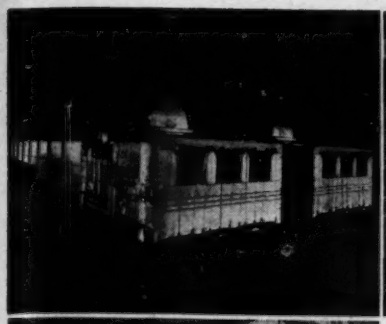
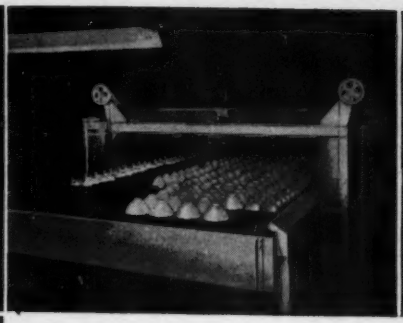
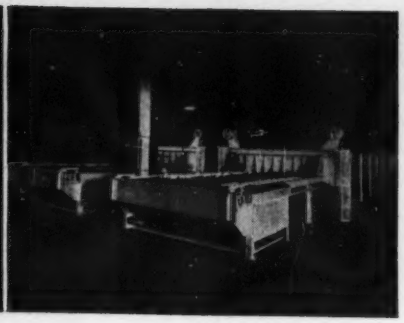
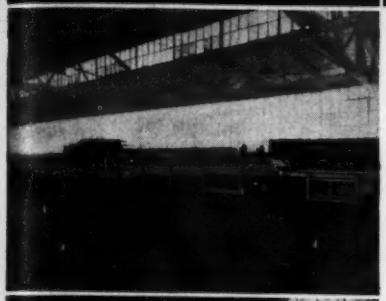

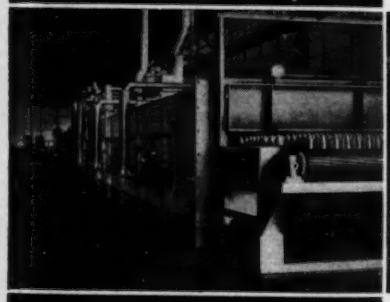
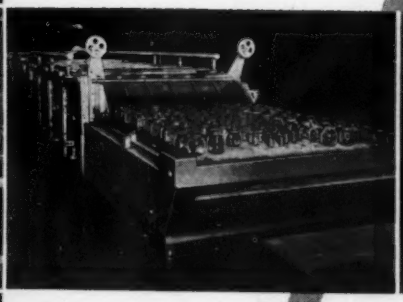

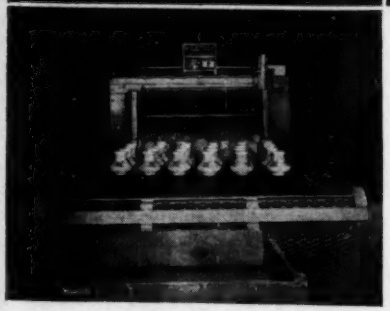

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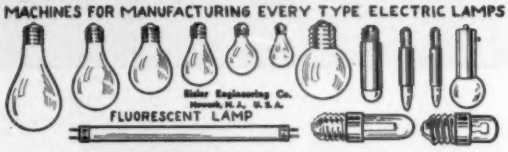

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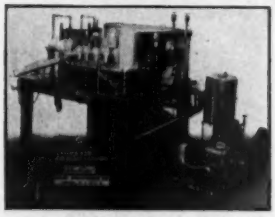

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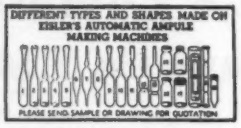
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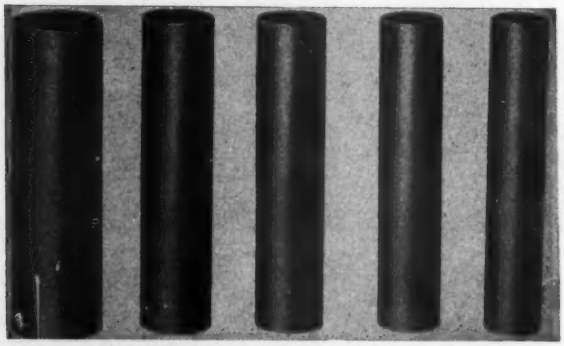

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MADE BY GUNITE FOUNDRIES ROCKFORD, ILLINOIS

GLASS MELTING . . .

(*Continued from page* 697)

tive large lumps of silica such as ganister in some manner such as illustrated in Fig. 1 so that the relatively soft, low viscous liquid of the melted briquette will pass over and contact these silica lumps, thereby picking up by solution and erosion the added silica desired.

Very little has been shown of the quite complex actions of the various stages involved in this proposed type of erosion melting. A more detailed and thorough presentation of these important stages will be given in the following chapters.

TRANSLATIONS OF RUSSIAN PAPERS . . .

(*Continued from page* 699)

Let us compute, e.g., the temperature at which the viscosity of 1000 poises is reached by glass containing SiO_2 71.95, Na_2O 15.82, CaO 10.11, MgO 1.00 and Al_2O_3 1.12%. This glass has the same percentages of SiO_2, Na_2O and Al_2O_3 as the glass of the above examples, and the sum of CaO +MgO is 11.11% as above. Therefore, before any correction is applied, the temperature 1167°C is found, see example 3. Since the glass contains 2% less MgO than 3%, the correction is $9° \times 2 = 18°$ and must be subtracted. Hence, the glass has the 1000 poises viscosity at $1167° - 18° = 1149°$C.

CERAMIC ENGINEERING ENROLLMENT AT N.C. STATE COLLEGE

The beginning of a new college year at North Carolina State College indicates that registration in the Ceramic Engineering Department has continued to increase. Over 76 students are enrolled in the department which is the largest number of students that has ever been enrolled at one time.

The department recently celebrated its 25th year, making it the oldest ceramic engineering school in the south. It is hoped that its facilities will be expanded in the very near future.

PPG ACQUIRES MIDVALE COAL COMPANY

Pittsburgh Plate Glass Company has acquired controlling stock interest in the Midvale Coal Company, according to a recent announcement. The coal company is being liquidated and its mine will be operated as the Columbia Coal Division of Pittsburgh Plate Glass Company.

It is reported that about 60% of Midvale's 2,000 ton daily production will be shipped by truck to the company's Barberton, Ohio, Columbia Chemical Division plant, where large quantities of fuel are used for power plant operation. The balance will be sold to regular commercial customers of the coal company.

ANCHOR HOCKING MAKES SALES STAFF CHANGES

Recent staff changes in the Package Sales Division of Anchor Hocking Glass Corporation have been announced by S. B. DeMerrell, Director of the Division. Mr. DeMerrell has named as assistant director of package sales, E. M. Lawrence who has been with the company since 1930. He had formerly been employed at the Salem Glass Works and the Capstan Glass Company, which companies became part of the Anchor Hocking Glass Corporation by a merger in 1937. Mr. Lawrence, prior to his present appointment, had served as Assistant Sales Manager of the Container Division.

J. E. Bellinger, formerly manager of the Detroit container and closure sales office of the company, has been named sales manager of General Line Containers. Mr. Bellinger has been associated with the company since 1934 when he joined the General Glass Corporation, later absorbed by Anchor Hocking. Since that time, he has served over various periods of time as sales representative in Milwaukee, Chicago and New York territories. He became manager of the Detroit sales office in 1946.

Other staff changes announced were the appointment of Edward Wells as sales manager of carbonated beverage ware and specialties, and R. B. MacFarlane, associated with the company since 1939, as sales manager of closures. Mr. Wells, who has been with the company since 1939, was formerly assistant sales manager of the container division.

A.C.S. PITTSBURGH SECTION CELEBRATES SESQUICENTENNIAL OF GLASS PRODUCTION IN THAT AREA

The Pittsburgh Section of the American Ceramic Society held a joint meeting with the Pennsylvania Ceramics Association and the Early American Glass Club of Pittsburgh at which they celebrated the Sesquicentennial of Glass Production in the Pittsburgh area.

The speaker for the evening, Mr. Lowell Innis, Honorary Curator of Glass at the Carnegie Museum, discussed the reasons for the growth of glass production in this area and illustrated his remarks by showing pieces of glass produced in the various eras. His exhibit included pieces of bottle glass made prior to 1800, glass molded by the pattern mold process and the pillow mold process, pieces showing the effect of early cut glass practice and early copper wheel engraving.

Mr. Innis also presented various examples of the pressed glass made after 1860, the latter showing evidence of the beginning of mass production processes. He concluded his talk with several slides showing many of the rare pieces of historical glass held by various collectors in the Pittsburgh area.

L-O-F EXPANDS SALES FORCE

The expansion of its sales organization by the addition of six field representatives in widely scattered trade centers throughout the United States has been announced by Libbey-Owens-Ford Glass Company.

The appointees are William C. Maxwell at Seattle; Joseph F. Hyland at Richmond; Chester E. Shepperly, Dallas; W. Z. Frederick Walker, Boston; James W. Blumer, Atlanta; and Robert W. Troup, New York.

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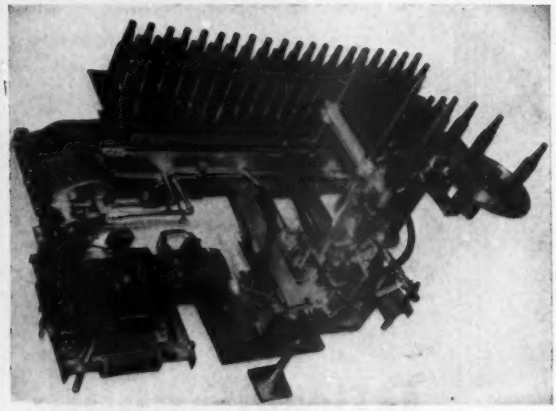

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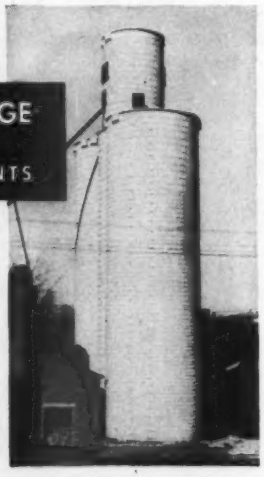

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The staves have matching grooved and beaded edges. Each stave interlocks with six adjacent ones. For contents which must be kept dry, dampproofing is accomplished by buttering the edges of the staves with mastic compound, coating the inside and outside of the bin with neat cement, and then adding two coats of waterproofing compound to the outside. To withstand internal pressure, the structure is bound with galvanized steel rings, as illustrated in the accompanying photograph.

If you are interested in storage bins which last for generations, get all the facts about Neff & Fry Super-Concrete Stave Bins. Complete information is yours for the asking. Write, wire, or phone.

THE NEFF & FRY COMPANY, CAMDEN, OHIO

NEFF & FRY STORAGE BINS

GLASS SECTION OF NATIONAL SAFETY COUNCIL HOLDS FIRST MEETING . . .

(*Continued from page* 700)

gospel of accident prevention.

"That is somewhat the kind of career this Glass and Ceramics Section should embark on to get desirable results. The opportunity is a challenge and you must accept responsibility for production of the technical safety material you yourselves need. Otherwise you will not be doing your full job as safety engineers, or as a National Safety Council section. As rapidly as we can, we will publish whatever you produce in the way of posters and safe practice pamphlets. We urge you to make this the best possible technical information there is."

A spirited account of how the Kimble Glass Division of Owens-Illinois Glass Co., developed a safety program sparked by intense employee interest at its Vineland, N. J., plant was related by Kimble's Personnel Director, Walter W. Woods. For good measure he added also some inspirational suggestions on how to become a "supersalesman for safety," as derived from his fifteen years of work in this field. Indicative of what can be accomplished, he said the number of accidents in the plant since inauguration of the safety program has been reduced 62 percent.

Karl Dunn, industrial hygienist at the Corning Glass Works, Corning, N. Y., offered some technical but common sense tips on control of the effects of heat and radiation in the glass and ceramics trade. Another speaker, A. S. Milner, General Manager, Milner Engineering Co., Muncie, Ind., presented an illustrated discussion of dust control by the company's new type glass batch house, with application particularly to potteries. Another technical paper, read by Milton M. Bowman, supervisor of accident prevention for the Cleveland, Ohio, transit system, proved especially instructive to a group of some twenty-five school boys in the audience. They comprised a class of industrial arts students in an Aurora, Ill., vocational high-school, whose teacher had brought them to the Chicago conference to learn early in their careers how to protect their eyes properly in industrial occupations.

In the election for 1948-49 officers of the Safety Council's Glass and Ceramics Section, Harold V. Gardner, Owens-Illinois Glass Co., Toledo, Ohio, was chosen General Chairman. John P. Stephenson, Ball Bros. Co., Mun-

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cie, Ind., was elected Vice Chairman and James L. Morris, Federal Glass Co., Columbus, Ohio, was selected as Secretary.

In recognition of his strenuous year of pioneering effort to organize the section's activities, the retiring Chairman, Fred A. Anderson, was presented with a scroll expressing the National Safety Council's appreciation. "His splendid work has started the group in the direction it should go," said Mr. Kelly, in making the presentation.

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According to a release from Westinghouse Electric Corporation, Fiberglas cloth is being employed as a series cutout between the lead-in wires of its gas-filled lamps used on the New York Subway where twenty lamps are operated in series on a 600-volt, d.c. circuit.

By inserting the Fiberglas between the lead-in wires, the necessary critical spacing is maintained. A strap of nickel around the wires holds them tight against the Fiberglas.

When the filament in any of the twenty lamps fails, the series circuit is momentarily broken and a potential of 600 volts is impressed across the lead-in wires of the failed lamp. An immediate insulation breakdown occurs through the interstices of the Fiberglas as the gas acts as a conductor. The result is a fusing together of the wires to maintain the series circuit. The cutout will operate without failure at 200 volts when sealed in the lamp at 500 volts in the open air.

PENNSALT ADDS TO STAFF AT WHITEMARSH LABORATORIES

The appointment of Hyman Iserson and Maurice E. Miville as research chemists at its Whitemarsh Research Laboratories has been announced by Pennsylvania Salt Manufacturing Company.

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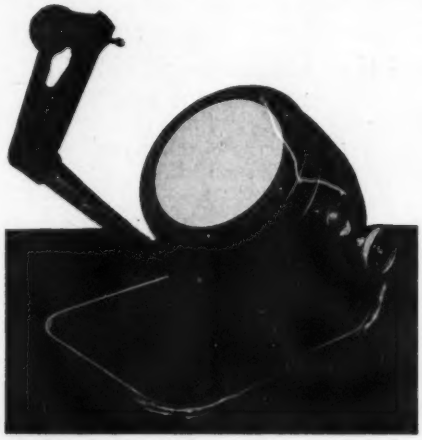

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WYANDOTTE NAMES RESEARCH ASSISTANT

An announcement has been made by Wyandotte Chemicals Corporation to the effect that Alexander Leggin has been named assistant to Dr. Thomas H. Vaughn, Vice President of Research for the company. Mr. Leggin, with offices in Washington, D. C., will act as liasion with Government agencies.

Mr. Leggin was formerly head of the Washington News Bureau of the American Chemical Society, and during the war, he served in the Chemical Warfare Service.

Prior to the war, Mr. Leggin held a Fellowship at the Mellon Institute of Industrial Research and later was head of a research division of Pittsburgh Plate Glass Company.

ANCHOR HOCKING MAKES APPOINTMENT

With the introduction of its new Jade-ite Fire-King glass dinnerware, Anchor Hocking Glass Corporation announced the appointment of Roger F. Hall as Promotion and Development Manager of that phase of the company's operations.

Mr. Hall has been associated with the glass industry for 25 years. For some time past, he has been in charge of Anchor Hocking's Baltimore Tableware Division sales office. Previously, he was associated with the McBeth Evans Glass Company and Corning Glass Works.

Named to succeed Mr. Hall as Baltimore Tableware Division Manager is Paul F. Stoudt.

PITTSBURGH CORNING DEVELOPMENT GROUP ADDS TO STAFF

S. Lewis Santomieri has joined the recently organized Pittsburgh Corning Product Development group operating from Port Allegany, Pa., it has been announced.

After graduating from the New York State College of Ceramics at Alfred University with a degree in Ceramic Engineering in 1938, he joined the Victor Insulators, Inc. He later served as Research Engineer at Battelle Memorial Institute and as Materials Engineer engaged in essential war work with the U. S. Maritime Commission in Washington, D. C. In this assignment, Mr. Santomieri worked with insulating materials which gives him an excellent background for his new job.

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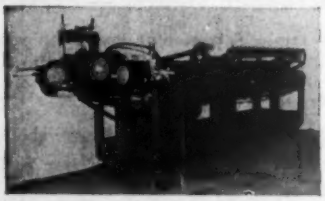

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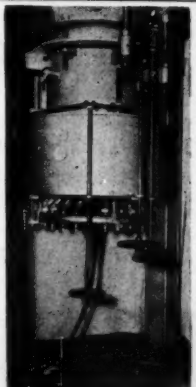

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the glass industry

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